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Rome, 5-9 June 1978

SELECTED WORKING PAPERS SUBMITTED TO THE NINTH SESSION OF ACMRR

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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RESEARCH REQUIREMENTS IN DEVELOPING COUNTRIES

by

The FAO Secretariat

1. INTRODUCTION

The basic outputs from biological and related research required by those in developing countries concerned with fisheries are very similar to those required in developed countries. Policy makers need information on opportunities for increasing catches from under-exploited stocks, and on the needs for management of heavily fished stocks, and at the operational level, fishermen and others need assistance in locating good grounds, and prediction of the likely magnitude of future catches. Thus it can be expected that the broad lines of fishery research (surveys, stock assessment, etc.) as they have become established in developed countries will be generally suitable for application in respect of the fisheries of developing countries.

However, there are some differences which should be taken into account in enabling developing countries to use fishery research and its results to their best advantage. These differences concern the capacity of individual countries to carry out research; the nature of the research and the topics covered; and the ability of countries to use the results.

2. RESEARCH CAPACITY

The present state of fishery science, particularly in developing countries, was discussed by ACMRR at its eighth session (Sesimbra, Portugal 1975) on the basis of preliminary information from a few countries. This revealed, not surprisingly, that there were big differences between countries in the absolute and relative amounts of resources devoted to fishery research. The Committee therefore agreed (paragraph 10 of its report) that an analysis of the state of fishery science covering the whole world would be useful. Accordingly a consultant was hired to carry out this study (see ACMRR:9/78/Inf.5[1/]). While, as was realized by the Committee at the time, difficulties regarding, for example, of what is meant by a fishery scientist, or the proportion of the total fishery budget that is actually used for research, as opposed to administration and other activities, made it impossible to carry out the study in as much depth as could be hoped, some important facts emerged.

The first is that, even though the analysis was somewhat selective, concentrating on those developing countries for which there was data, and, therefore, probably above-average research capacity, the number of fishery scientists in developing countries was very low - often less than ten - compared with the developed countries considered (up to several hundred). However, the differences between developing countries and developed were much reduced when account was taken of the factors that must have some influence in determining the number of fishery scientists such as the total resources of the country (e.g. population or gross domestic product), its overall scientific capacity (e.g. total number of scientists), or the importance of fisheries to the national economy (value or weight of catch). In these terms there was much less difference between the two groups of countries; there is, for example, a particularly close correlation between GDP and number of fishery scientists, with the points for developed and developing countries falling on the same line (see Fig.2 of ACMRR:9/78/Inf.5). Also, the percentage of scientists of all types and qualifications in a country who are working in fisheries is, on the whole, noticeably higher in developing than in developed countries (0.2 percent to 8 percent, compared with 0.01 percent up to 0.9 percent).

1/ A comparison of national resources available for fishery research, by Christine L. Dawson FAO Fisheries Circular 348

We may conclude that the main obstacle to increasing the overall volume of fishery research in most developing countries is their size and state of development; the former is constant, and the latter will be changed only slowly. Though there are obviously some countries where the resources assigned to fishery research can and should be increased, in most cases the question is one of making the best use of existing resources. In this connection it must be stressed that poor research can be as expensive as good research. Thus improvement in the output from fishery research need not involve great additional expense in laboratories, research vessels, etc. (which account for a high proportion of the total costs of fishery research), but will certainly involve attracting high quality scientists, and providing them with the opportunities to do good work. While it is extremely difficult to assess objectively the quality of scientists involved in fishery research in developing countries as compared with other scientists in the same countries (e.g. in universities), or to fishery scientists elsewhere, it does seem that in at least some countries the quality is unnecessarily low. This is associated with a number of institutional problems, e.g. the low status given to fishery science or the competition between different institutions concerned with different aspects of marine or freshwater research. There are often opportunities for considerable improvement in the quality and usefulness of fishery research by tackling these institutional constraints (e.g. by paying scientists in government fishery research laboratories salaries commensurate with those received elsewhere) without much increase in costs. These matters are also discussed in a later section in relation to the way that the results of fishery research are used. The difficulties arising from the small number of scientists in individual countries can also be reduced by close international cooperation, especially at the regional level. This is discussed under item 8 of the provisional agenda (see ACMRR:9/78/9).

One real problem in fishery research in many developing countries is that it is a new activity. In most developed countries research has grown up, over a period of decades, more or less hand in hand with the development of the fisheries themselves. As the problems of the fisheries develop, so too has the capacity of research to deal with them, usually but by no means always, more or less in step, and often as a result of trial and error. The fisheries in many developing countries have grown from a primitive stage to full development, with all the problems of such fisheries, almost overnight, with little chance for local fishery research to grow and adapt to the changing situation. Peru and Thailand are extreme, but by no means untypical examples of this growth. Assistance has been given, noticeably to Peru, to enable countries in this situation to bring their research capacity into line with their needs, but more assistance and advice is needed.

Another aspect of this rapid growth is the lack of experience in research administration. Administrators in developed countries have learnt that research is a slow process, and that though good equipment (including research vessels) is needed, still more essential is the trained staff to know how to use it, and the continued and regular financial and other support so that they can use it. All too often the research staff that should be doing the basic work to provide long-term advice is moved from task to task in a "fire-fighting" capacity; again it is not unknown for expensive research vessels or other equipment to be bought but lay idle because there is not the money to run it, or the staff who knows how to use it.

3. TOPICS OF RESEARCH

Fishery research grew up in a small number of countries around the North Atlantic and North Pacific, and initially dealt with a few individual temperate species (salmon, cod, etc.), subject to large commercial fisheries. The fisheries in developing countries have, at least in the past, been largely at the artisanal level, based on a mixture of many tropical species. Thus it might be expected that many of the topics of traditional fishery research are not immediately relevant to the problems faced in developing countries. The differences should not however be exaggerated; the problems of the Peruvian anchoveta fishery are very similar to many herring or sardine fisheries in temperate waters, and those of the Gulf of Thailand trawl fishery are remarkably similar to those of the North Sea trawl fishery some half-century earlier. Also, the pressures for advice in respect of the fisheries of developed countries are modifying and adding to the types studied (e.g. problems of multi-species fisheries) in a way that makes them more applicable to developing countries. For

example, developing countries (Peru, the countries bordering the Arabian Sea, etc.) have been among the chief beneficiaries from the new techniques of acoustic surveying. Nevertheless, the interests and problems of countries are not identical, and there are probably some topics that are very important to some developing countries, but which are of only marginal interest to the large laboratories of developed countries. In these situations, it can be useful to hold small meetings, such as the consultation held in September 1977 on multi-species problems. ACMRR might wish to identify topics that are of particular interest to developing countries, and to suggest ways in which these topics could be tackled.

4. USE OF RESEARCH RESULTS

The purpose of carrying out fishery research is for it to be used to improve the performance of fisheries in some way or other (higher catches, cheaper fish, increased average income to fishermen, etc.). This might appear so obvious as not to be worth saying were it not for the fact that all too often the results of fishery research are not used. Studies that could be of direct relevance, say, in planning future development appear in scientific reports and are then forgotten; thereafter the scientists may be discouraged from pursuing topics of potential application, and work on problems that appear scientifically more challenging and rewarding. This is not a problem unique to any group of countries, and the need to establish close links, and an effective mechanism of exchange between the producers and the users of fishery research is of general relevance. After nearly a century of fishery research on the North Atlantic and North Pacific these links have become reasonably well established in most of the major fishing countries of the developed world. There are exceptions, and the sudden growth of concern with fisheries at high levels of national policy-making in connection with the extension of limits of jurisdiction has shown up some of the inadequacies of some existing mechanisms, as well as producing improved arrangements.

Developing countries, however, have some of the biggest problems, and the least adequate machinery, particularly in those countries where the government administrative machinery in general is weak. When only a few people are concerned with research and administration, it is important that they work smoothly together, and also have good contacts with those actually fishing, on both the artisanal and industrial scales. One organizational approach to this is placing fishery research within the fishery structure. However, there may also be advantages in linking fishery research more closely with other scientific research; consequently the administration of fishery research is, in some cases, placed in a general research unit within the Ministry of Agriculture. ACMRR may wish to comment on these alternatives, as well as other possible structures and links (e.g. with university department of biology or marine science) which could result in, on the one hand, research being directed more effectively towards urgent problems, and, on the other, those concerned with all aspects of fishery policy making more effective use of the research that is actually done.

While the main and most immediate users of research results will be policy makers and others in government administration, those ultimately affected are the fishermen themselves. It is clearly important that there should be links between research and the fishermen, not least to help the scientist interpret data from the fisheries. The need for such links and understanding by the fishermen of the implication of research results will become (and has become in many places) vital when the research shows that controls and management are needed, since unless the fishermen are generally convinced that some sort of control is needed, enforcement of controls is likely to be poor or ineffectual. In some countries these links are maintained by production of semi-popular magazines. ACMRR might wish to discuss the usefulness of this, or other methods of disseminating research results.

Another important aspect of the use of the results of research by developing countries is the degree to which they can take advantage of research relevant to their problems but carried out elsewhere. This touches on the wishes of countries to lessen their dependence on others, and on increasing their degree of self-determination. Ideally, most countries would like to carry out themselves, or at least be closely involved in, all the research relevant to their problems, as well as determining policies for development, utilization

and management of their resources. Such complete autonomy is not practicable, except possibly for the largest fishery countries such as Japan or U.S.A; some degree of inter-dependence must therefore be accepted. Here it should be noted that essential aspects of independence and self-determination lies less in the actual scientific studies than in the interpretation of the results, and the choice of policies in the light of these interpretations. While it is difficult to make a useful interpretation without some familiarity with how research is actually carried out, it would appear to follow that where a country has limited scientific resources, and needs to use the results of research in determining and implementing its fishery policies, it should give priority in using the available scientific talent in the policy making process. If this conclusion is correct there are consequences both within countries, in the structure and staffing of fishery administration (there is the need for scientists in senior positions close to the decision-making level to make sure that the decisions made do take full advantage of all relevant scientific results) and at the international level, in respect of assistance in various aspects of fishery science. Traditionally, much of the assistance in the field of fishery science given to developing countries has been devoted to building up their capacity to carry out directly fishery research - establishment of institutions, fellowships for promising scientists - with some concentration on fairly high level research. While this type of assistance should undoubtedly continue, more assistance may need to be given on the one hand to improving the capacity to collect basic information (e.g. in the collection of statistics), and on the other hand to improving the capacity to use the results. The latter means that fellowships or similar training should be linked less to high-level research institutes (often the universities) and more to government institutions where research results are actually used.

5. ACTION BY ACMRR

The previous sections have discussed briefly some of the problems in carrying out fishery research and using the results which are of particular concern to developing countries. Some of these are also discussed in Information Papers 5, 6 and 7. The points that seem to merit special attention are the structure of fishery research institutions and their relation to other institutions in the country; the identification of certain topics which are for ecological or other reasons of more direct concern to developing than to most developed countries (e.g. tropical reef fisheries); and the degree to which developing countries should concentrate on the best use of existing research results, rather than on carrying out further original research. The Committee should discuss these conclusions, and whether they need to be added to or modified. It then should discuss what action it might take to tackle this problem, e.g. to suggest a structure or structures for fishery administration or to identify particular topics that might usefully be looked into in more detail by consultants or working groups, or conclusions that should be communicated to Member Governments. The Committee may wish also to examine existing mechanisms of communicating research results among countries, particularly from relatively developed to less developed, to see if they can be improved. In particular it may wish to examine FAO's traditional role in such communication and suggest ways in which it might be strengthened.

PRINCIPLES OF DETERMINING ALLOWABLE CATCHES WITH PARTICULAR REFERENCE TO SHARED RESOURCES

by

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1. INTRODUCTION

From the title of this agenda item and the annotation which follows it, one may get the impression that the guidelines set out in articles 61 and 62 of the Informal Composite Negotiating Text for UNCLOS form a basis on which the scientists/administrators can establish a management regime for fishery resources which functions satisfactorily from both the points of view of utilization and conservation. This, as I think all fishery scientists will readily admit, is very far from being the case. There are two levels of problems here. Firstly, the text itself with its reference to MSY "as qualified by relevant environmental and economic factors, including the economic needs of coastal fishing communities" ... "and taking into account fishing patterns" is ambiguous and self-contradictory and would not seem to ensure conservation.

Secondly, I think we have to admit that the "state of the art" of our fishery science leaves much to be desired. The lack of clarity and the non-professional form of the relevant parts of the UNCLOS text is probably largely a reflection of the inadequacies of our science, or at least its application.

Even though the main emphasis in this note will be on the problems of determining allowable catches for resources shared between EEZs, for which there is no indication of guidelines or principles in the UNCLOS text, I will first present some comments on the problems of guidelines and principles for resource management in general, since the Committee may wish to keep this important topic under current review.

2. GENERAL PROBLEMS OF DETERMINING THE BIOLOGICAL BASIS FOR FISHERY MANAGEMENT

This subject has been repeatedly and extensively reviewed over the last five years or so, and I will here only sum up the situation as I see it in a few paragraphs.

It is now increasingly recognized that the MSY as an objective or principle for fishery management has only a limited usefulness. The limitations are first of all related to the fact that for many important resources it has not been possible to establish the corresponding yield curves because recruitment at different stock levels cannot be predicted with reasonable reliability. The stochastic models which are now being applied cannot provide short-term assessment with better predictability, but may improve the information basis for long-term management strategies. As more information becomes available on the reaction of the various types of stocks to exploitation and environmental pressure, and of interrelations between stocks, the advisory systems will evolve toward a more differentiated approach which takes account of special stock-recruitment relationships, biological characteristics of particular significance for management such as life-span, density-dependent growth and maturity, behaviour patterns which affect catchability, and also type and timeliness of the scientific information which is required. It thus seems likely that the forthcoming Symposium on the Biological Basis for Pelagic Stock Management will conclude that small

pelagic fish stocks must be harvested at a lower level than that corresponding to the MSY. Very short-lived small pelagic fish present special problems especially if they are subject to great year-to-year fluctuations in biomass. Their proper management would require a rapid and timely assessment of recruitment. In long-lived stocks a buffer-stock would offer various advantages in terms of high catch rates and less fluctuating TACs, but its size must be determined in relation to a possible density-dependent growth rate, grazing on other useful resources etc. The interrelationships between stocks is an area where we perhaps may expect the largest leap forward in knowledge since at present we hardly know anything. It seems, however, doubtful whether models of these relationships can be given a reasonable predictability, since environmental factors will form important parts of the systems. The models may still be essential for long-term strategy formulation.

3. THE SPECIAL PROBLEMS OF SHARING RESOURCES BETWEEN EEZs

Under the new economic zone regime, fishery management requires tasks additional to those of manipulating the total fishing effort and its distribution on the various size or age categories of the resource. These are related to the fact that in many areas the distribution of major fish stocks cover more than one coastal zone. Thus, in the northeast Atlantic all of the important Barents Sea stocks will be shared between the U.S.S.R. and Norway, the North Sea stocks between Norway and the Common Market countries and, in part, Sweden, and the Baltic stocks by all the Baltic States - Finland, U.S.S.R., Poland, Sweden, Denmark, the Federal Republic of Germany and the German Democratic Republic. We are, in fact, confronted with an entirely new problem in international fisheries work: to undertake an allocation of various parts of a fish stock or unit resource between national parties. While article 63 of the ICNT refers to such situations, one seeks in vain for guidlines of principles of how to deal with them. The relevant countries are simply advised to cooperate in solving the problems. The problem is by no means restricted to the northeast Atlantic region. Similar situations where resource-units are shared between several coastal zones or between a coastal zone and international waters occur in many important fishing regions around the world, such as off the northwestern and southwestern coasts of Africa, southeast Asia and others.

How then can we deal with such shared resources both from the point of view of resource management and of their allocation? The first priority for fully-exploited stocks must be to establish a system of joint overall management of the resource in its entire area of distribution in accordance with the generally accepted criteria for rational usage and conservation of fishery resources. Ordinarily, such systems will include the setting of a TAC, total allowable catch, for the stock on an annual basis. The next step, the allocation of this TAC to the coastal states in whose zones the stock occurs could then conceivably take the form of establishing sub-quotas by zones. In attempting this direct approach in the northeast Atlantic region, a number of difficulties have been encountered. The apparently simplest solution would seem to be to base the allocation on historical fishing splitting the total TAC in proportion to the current yields in the various zones or the means of a recent period. This would, however, give a reasonable allocation only for stocks which have been exploited at approximately the same rate in each of the zones. But for many stocks the fishery has, for various reasons, been concentrated to particular parts of the distributional area of the fish. Furthermore, considerable fluctuations will often occur in the distribution of many fish stocks, both seasonally or over a shorter or longer period of years, and this will evidently complicate a simple "historical" allocation. The question of what historical period to use as a basis is often in dispute on principle, since the fishery policy of some countries may have been more dynamic and changeable than that of others.

There are also more fundamental objections against basing these very important and definite decisions concerning the allocation of the resources merely on the fishing pattern of some recent years. The harvestable part of a fishery resource represents only one component of a resource complex which, in addition, consists of a reproductive phase and a recruiting and growth phase. Further, the whole resource complex is, of course, dependent on the system of productivity at lower trophic levels in the sea. The geographical distri-

bution of these various phases and of the system of primary production in the sea does not necessarily coincide with that of the fishable part of the population. For example, the main areas of the juvenile pre-recruit fish may not be located in the zone in which the main fishery occurs. A clear example of this is demonstrated by the stock of blue whiting in the northeast Atlantic. The biomass of this stock, which has a fishable potential of the order of one million tons, is largely produced in the economic zones of Norway, Iceland and the Faeroe Islands. Most of the harvest is, however, likely to take place in the economic zones of Great Britain and the Faeroes, where the fish gather during the spring months in fishable concentrations for spawning. Generally, it would seem unreasonable not to consider the non-fishable components when allocating the access to a resource.

Other problems that may arise when splitting a total TAC into subquotas by zones relate to the state of exploitation of the stock in question. Exploitation pressure may cause changes in the distribution and migrations of the population and will thus affect the allocation problems. For example, the stock of North Sea herring is, in its present state of extreme over-exploitation, limited to the southern and western parts of the North Sea, whereas previously it also occurred in abundance and was fished in the eastern parts. Similarly, the area of distribution of the Atlanto-Skandian herring has been reduced from the oceanic parts of the Norwegian Sea and Barents Sea to the coastal banks and fjords of Norway following the collapse of this stock at the end of the sixties.

A further problem of systems of quota allocations by zones for shared stocks is that the geographical distribution of the fishing operations may have consequences for the management and conservation of the stocks. An intensive fishery in a zone dominated by young fish may reduce the total yield and endanger the stock. Obviously, the fishing pattern can be optimized by regulation of fishing gear or minimum landing size of fish, but if such regulations discriminate against the fishery in one particular coastal zone they would tend to be unacceptable. A case in question is represented by the stocks of Arctic cod and haddock in the Barents Sea, where the juvenile and pre-recruit fish dominate in the economic zone of the U.S.S.R., while the adult components are predominantly found in Norway's zone.

The occurrence of units of resources which extend over several coastal zones or into international waters also poses special problems in relation to the "surplus" concept of the LOS (article 62 of the ICNT). A surplus can only be defined after a total TAC has been set and an allocation between the relevant coastal states agreed upon. For stocks which extend into international waters, the determination of surplus must follow a quota allocation for the free oceanic area. A related, but perhaps more general problem of definition of surplus arises in situations where a coastal state may wish to make use of the whole or a part of its allocated quota of a given stock in exchange for fishing rights on other stocks in a neighbouring zone. Such practice is likely to be followed in many areas in order to avoid as far as possible disruptions of established fisheries and it seems doubtful whether the surplus concept is relevant in relation to such arrangements.

These examples demonstrate that the complex and often varying nature of fisheries and fish resources seriously complicates adaption to a rigid system of economic zones, particularly in areas where resources are shared. The new and difficult task in such areas is to apportion rights to the resources. Such allocations will have to be based on a number of criteria, of which the following may be the most important:

- the occurrence and migrations of the fishable part of the stock;
- the occurrence of juvenile and pre-recruit fish;
- the spawning areas and the distribution of egg and larvae;
- the history of the fishery including the distribution of catch, rate of exploitation and fishery regulations;
- the state of exploitation of the stock.

Information of this type may then form the basis of negotiations for a long-term proportional allocation of the potential yield. It would not be practicable to adjust this allocation to short-term changes and fluctuations which may occur in the distribution and migrations of the stocks, but revisions may have to be made from time to time for stocks with major long-term fluctuations.

According to the ICNT, states will be obliged to set a TAC for all stocks within the economic zone including shared stocks. But for the latter, the zonal quotas must, of course, be part of an agreed overall TAC for the stock in question.

Such annual subquotas by zones should, however, not necessarily reflect the long-term allocation of the resource between the coastal states. The zone quotas should, in general, be determined on the basis of a policy of good resource management and information on the predicted availability of the harvestable part of the resource. This implies that states which share a resource may find benefit in allowing access to the stock on a mutual basis in its total area of distribution. Once agreement is reached over the long-term resource allocation, the establishment of zone quotas is of secondary interest and may perhaps be dispensed with. From the point of view of conservation, the decisive factor is agreement on an overall management scheme. Determination of zone quotas for shared stocks will often represent additional and unnecessary regulations which may, in fact, form obstacles to an economic and rational conduct of the fishing operations.

The information basis which will be needed both for the introduction of the new regime and its continued monitoring should be provided by joint efforts of experts representing all interested parties. This work may perhaps most suitably be organized by regional fisheries bodies, and this is the arrangement agreed upon in the northeast Atlantic, where the ICES has been asked to undertake this task.

4. INFORMATION BASIS

Determining allowable catches as outlined above will require, especially for shared resources, an extensive information basis. The needs can be classified as follows:

<u>On stocks</u>:	Stock structure
	Stock distribution
	Surplus production estimate
	Biological history
	Ecological relationships
<u>On fisheries</u>:	Development history
	Classification by gears and stock
	Geographical distribution
	Distribution by fleets
	Exploitation effects

Much of this information will not be readily available, as even northeast Atlantic fishery scientists realized when confronted with the shared resources problem. Programmes for the compilation of information and for the required research should be developed for actual areas. Fish surveys will probably prove to be indispensable tools in many of these programmes.

PROBLEMS AND PROGRESS IN OCEANOGRAPHY RELEVANT TO FISHERIES

by

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1. INTRODUCTION

By its nature, fishery science, in the narrow sense, has concentrated on certain rather restricted and practically orientated problems, essentially those immediately and obviously required by policy makers in the development and management of fisheries. At the same time, oceanographers, using the term in a wide sense to cover all those, whether biologists, physicists or others who are studying the oceans and the life in them, are carrying out much research that can be, possibly only in the long run, of direct interest to fisheries. More use of the results of non-fishery oceanographic research would likely be made by fishery people, and the oceanographic research might be more likely to be directed into fields potentially useful to fisheries if there were a clearer identification of the specific aspects of fisheries and research into fishery problems at the present time and in the near future, which are likely to benefit from oceanographic studies.

Synoptic oceanography can produce results of direct interest to fisheries and hence help fishery-directed research in four main areas - abundance fluctuations; the distribution and vulnerability of major fish stocks; the flow of energy through the food chain, including related aspects of the interaction between species; and the factors affecting recruitment. These are discussed in the following sections.

2. FLUCTUATIONS AND FORECASTING

Fish do not live in a constant environment, and fish stocks and fish catches vary from year to year. While the exact links are uncertain - it is not known why, for example, the North Sea haddock had such a very good year-class in 1967, or why the Californian sardine has varied between abundance and scarcity over periods of centuries - it is clear that climate (in a wide sense) does affect fisheries, and there has been a growing interest in this effect (see Cushing and Dickson, 1976, for a recent review). At the same time, there has been an increased interest on a wider scale in the effects of climate, due in part to the problems of the unusual drought in the Sahel zone of Africa. In response to this interest the World Meteorological Organization is convening a World Climate Conference, to be held in February 1979, further information on which is given in Appendix 1 (Information Bulletin for Overview Speakers). As part of FAO's support to this Conference, the Fisheries Department has arranged for Dr. D.H. Cushing, F.R.S. (Fisheries Laboratory, Lowestoft, U.K.) to prepare two papers - one on the general effect of climatic variations on fisheries, and the other on the specific example of "El Niño" and the Peruvian fisheries; draft outlines of these papers are given as Appendixes 2 and 3.

In studying the effect of environmental fluctuations on fisheries and particularly in establishing any system of forecasting, two distinct problems are met. The first to determine which specific environmental parameter (or parameters) affects fish stocks (especially the strength of year-classes), and to establish the quantitative links between them, for example, temperature and year-class strength. The second is to understand the general climatic

factors which influence the critical paramater and thus be in a position to make forecasts. The latter is a very general problem affecting farmers, proprietors of holiday hotels, etc., and is being widely studied by many groups. The role of the Fisheries Department of FAO seems chiefly to be in touch with these activities, to be aware of anything that might be of value to fisheries and, as appropriate, bring any relevant activities to the attention of the fisheries community, especially those fishery scientists in developing countries who do not have good contacts with general scientific work.

The first point is essentially a fishery problem and one that has sometimes been neglected, e.g. it is sometimes assumed that the ability to forecast "El Niño" will immediately enable the catches of anchoveta to be predicted, although at different times the occurrence of "El Niño" has had quite different effects on catches (e.g. the effects in 1965, 1972 and 1976). The practical difficulty is that, given the wide range of environmental parameters that might affect year-class strength or vulnerability, it is nearly always possible in respect of a particular stock, with a set of data covering only a few years to find some parameter that appears to show a high degree of correlation with year-class strength or vulnerability. But correlations often fail to hold for later years. The solution seems to be to obtain a better and deeper understanding of what affects the survival and behaviour of fish. Year-class strength is discussed in a later section dealing with stock and recruitment.

In studying the interaction between the gross fish catch at one extreme and oceanwide climatic conditions at the other, there are types of more detailed information on fisheries or environment which, if made more generally available, especially to the non-specialist, could be helpful. For example, the oceanographer attempting to correlate his observations with fishery events would be much more likely to obtain meaningful results if, instead of total catch, he had available to him regular data on year-class strength, or deviations in catches, or catches per unit effort, from those expected from a simple catch/effort relation. Similarly, there may be certain types of environmental data that would be particularly valuable to fishery scientists.

3. FISH DISTRIBUTION AND VULNERABILITY

When new fisheries are beginning, or being considered, information from biological oceanography can be helpful in pointing out where promising areas exist and, with rather less precision, what is the possible magnitude of the catches that can be taken. For example, studies of the biological and physical oceanography of the northern Arabian Sea had shown, around a decade ago, that this was biologically a productive region and that, therefore, there should be substantial fish resources. Subsequent fishery-directed surveys with acoustic and fishing gears have confirmed this supposition, though have also shown that the fish are not all of the species types, or in the kind of concentrations, to make fishing for them highly attractive.

With, on the one hand, the reduction in the number of areas which remain unexplored for fishery purposes and, on the other, the improvement in the methods of direct fishery assessment (e.g. by acoustic surveys) the demand for information from biological oceanography to use in this way is decreasing.

The relation of fish distribution to oceanographic features, both biological and physical/chemical, is also of potential value to ongoing fisheries, particularly to practical fishermen, in locating favourable areas of high vulnerability of fish within the whole distribution of the fish stock. Both average locations and the variation in actual location may be of interest. Generally, the oceanographic features concerned should be simple and easily recorded (e.g. surface and sub-surface temperatures) if they are to be of practical value. Biological studies can be of value in outlining the physiological or other needs of the fish and hence suggesting the physical conditions that they will find favourable. For example, skipjack need to swim fast enough not to sink; to do this they need a minimum

amount of oxygen in the water, but the temperature should not be so high that their exertions cause them to be cooked. The observed distribution of most large skipjack fits well with that predicted from these facts.

Such observations are scientifically interesting for any fish. They become of immediate practical benefit if they allow the fishermen to find good fishing spots significantly faster than they would have done by relying only on other methods - experience, exchange of information with other fishing vessels, or with direct fish-location devices such as sonar, birds and the human eye. This will apply most strongly when the fish concerned have a wide and variable distribution, which is closely related to readily observable oceanographic features (especially surface features), for which the range of detection is small compared with possible variations in distribution, and for which the fishing fleet as a whole does not have a searching capacity to follow quickly all the movements of the fish. These conditions are most fully met by tunas and it is, therefore, no surprise that some of the most interesting studies of the relation of fish to its environment, and most of the practical applications of oceanographic data to fish location have been for tuna (e.g., Tomczak, 1978) though other examples can be found in areas with special conditions. For example, oxygen-deficient layers (e.g., off Peru, or the west coast of India at certain stages of the monsoon) are associated with lack of bottom fish. However, tuna are a special case. While the distribution of all fish stocks is related to environmental factors, in most cases the fishermen can locate good fishing grounds from past experience, use of echo-sounders, etc., sufficiently quickly, or the relation between environment and fish is variable or it is impracticable to observe closely and rapidly the changes in environment. Then the knowledge of the relation between fish and environment has less immediate practical value and the fisheries interests have less need to press the biological oceanographers to pursue these studies as a matter of priority.

4. PRODUCTION AND FOOD WEBS

A complete understanding of the biological basis to fisheries would presumably include a quantitative description of the flow of energy through the food web, from the original sunlight and primary production to commercial fisheries. To do this would make demands for data that (looking at the matter in the most optimistic light) are only now beginning to seem practicable even in the best studied areas (North Sea, California current system). Up to the present, therefore, comprehensive productivity studies have not been as useful in fisheries as studies of particular aspects; for example, the location of high biological productivity (e.g., the northern Arabian Sea as noted earlier) or in obtaining rough estimates of the possible fish production. Estimates of total world fishery potential have been deduced from data on primary production, using various assumptions on the trophic level at which harvesting is done, and the transfer efficiency between levels. These give answers roughly comparable with those obtained from other methods, and fair agreement has been obtained in respect of resources in particular areas, e.g., North Sea (Steele, 1965), off Peru (Ryther, 1969; Cushing, 1969). However, the fact that, in the case of Peru, the values of particular elements (transfer efficiency, primary productivity, etc.) used by different authors were different, and if interchanged would give very different results (Paulik, 1971), suggests that this approach, on data generally available at present, can be relied upon only when backed up with other information.

The direct value to fisheries of productivity studies, which on the preceding analysis may seem to be rather limited, will probably increase in the future. There are two reasons for this - scientific and practical. The scientific is that our understanding of the flow of energy through the food web is improving, with better quantitative data at several stages, and more sophisticated models (though in some cases the degree of sophistication may have outrun the supply of data). Thus it can be expected that more reliable estimates will be obtained of the production occurring at different trophic levels.

The practical reason is that, in any given region, fisheries are exploiting an increasing range of species. The traditional single-species approach to fishery assessment and management is inadequate to deal with these multi-species situations (e.g., FAO, 1978). Sufficient supply of data and scientific manpower is seldom available to study each and every species in the desirable detail, even without taking account of possible biological interaction between species. These are often suspected to be large, though they have seldom been quantified. Many of the relations are related to the flow of energy through the food web - competition for food, or predation - and because the individual fish can change its trophic level as it grows from larva to adult, the interactions, even between a few species, can be complicated. For example, herring and mackerel compete for food at all stages; adult mackerel eat small herring; adult cod eat adult herring, but adult herring and mackerel may eat larval cod, etc.

Two broad practical questions have arisen in a number of areas in relation to this subject; first, the degree to which, in regions where there are many species, the total fish production and the amount potentially harvestable, tends to be constant despite fluctuations in the abundance of individual species arising from fishing or natural causes; second, the degree to which simultaneous harvesting of predator and prey is possible, and especially the extent to which intense fishing of a prey species can seriously affect the predator.

The first question appears to arise in its most critical form in relation to shoaling pelagic fish, and arises from such observations as the almost simultaneous decline of the sardine and increase in anchovy in the California Current (Murphy, 1966), or the fact that the Japanese catch of pelagic fish has remained roughly constant despite very large (two orders of magnitude) changes in catches of individual species (Nagasaki, 1973). The critical question then often arises, if the favoured species (California sardine, Peruvian anchoveta) declines, of whether fishing on other species should be intensified (to allow the preferred one to recover) or should be carefully controlled (to protect at least what stocks still remain). This is not easy to answer but though the answer may not be identical in all situations, it does seem that the general nature will be similar in all cases, and that a comparison between different situations should be helpful for the scientists and those they are advising in respect of particular regions.

The problem of the constancy or otherwise of total fish production and the degree to which the flow of energy from primary production, if not taken up by one fish species because that has been depleted by heavy fishing, is used by other fish species and increases their production, occurs in a more general form in areas like the North Sea. Here the decline in mackerel and herring has coincided fairly closely with increases in several other species, both larger (cod, haddock) and smaller (sprat, Norway pout). Cause-and-effect relations can easily be suggested and can be illustrated by computer models (e.g., Anderson and Ursin, 1977) but are far from being proved. However, the existence or otherwise of such relations are critical in determining the optimum management policy for the North Sea.

Policy questions can also arise in relation to predator-prey systems and the political aspects have been particularly critical in respect of marine mammals, which are important predators in several systems, notably the Antarctic. The obvious ideas - on the one hand that removing predators which would have eaten X thousand tons of prey species will result in immediately harvestable "surplus" of X thousand tons or, on the other hand, that catching large quantities of a prey species will necessarily imperil the successful growth of the predator species - are clearly too simple to be completely accurate. However, despite uncertainties about the quantitative effects, predator-prey interactions must be of this qualitative kind - exploitation of predators allowing a greater prey harvest, but exploitation of prey reducing the sustainable harvest of predators. A better understanding of these systems in general will undoubtedly assist in the management of systems such as the Antarctic krill-whale-seal system, or that of capelin, cod and seals in the northwest Atlantic.

5. STOCK AND RECRUITMENT

The biggest scientific question in the management of single-species fisheries concerns the relation between the size of the adult stock and the average recruitment from that stock size. For many stocks it is relatively easy, from a knowledge of the mortality and growth rates after recruitment, to estimate the fishery pattern that will give the optimum yield per recruit, but unless there is truly such an "average" recruitment, this pattern may be very different from that giving the optimum total yield. The empirical study of stock and recruitment is made very difficult by the fact that, for most stocks, the recruitment from a given stock abundance is highly variable. This variability, and its relation to environmental factors, is of considerable interest in itself. If a relation between recruitment (year-class strength) and some characteristic of the environment (e.g. average water temperature in the two-month period after spawning) can be established it should be possible to provide from environmental data, a medium-term forecast for the future success of the fisheries. The difficulty here is that, in the absence of a basic understanding of the factors determining the survival of the early life-stages of fish, there are a very large number of factors that might be relevant. Given the normally small number of years for which data on year-class strength are available, it is not difficult to find some set of environmental factors that have a high correlation with estimated year-class strength. It is, therefore, not surprising that many studies have been published noting correlations between year-class strength and various environmental factors, nor that, with some exceptions (e.g. temperature and west Greenland cod) few of these have stood the test of time.

While the examination and analysis of a series of observations on adult stock, year-class strength and environmental factors will continue and will, in favourable circumstances, give useful results, progress in respect of most stocks in determining the stock level and fishing rate required to give optimum recruitment, and in forecasting the recruitment likely to occur in a given year, will require a better understanding of the process determining year-class strength.

One aspect of this is the establishment of general patterns of the form of the stock/recruitment relation under average environmental conditions, for different groups of fish, e.g., a broad flat-tipped curve for flatfish, a marked peak for salmons, etc. (see for example, Cushing, 1971). Another aspect is the detailed study of the dynamics of the early stages. This was discussed at the ICES/ICNAF/FAO Symposium in Aarhus in 1970 (Parrish, 1973). Since that time the volume of information has increased, and in respect of certain species, e.g., sardine and anchovy, the relation of food supply to survival and growth is being clarified. An interesting feature of this is that the food density required for adequate survival seems to be appreciably above the average density in the sea. That is, recruitment may depend on certain larvae finding patches of unusually abundant food. Fortunately, patchiness seems to be a feature of life in the oceans (e.g., Steele and Henderson, 1977). This suggests that a pair of promising approaches to the problem might be an intensification of the current studies on the food requirements of fish larvae, and studies of the meso-scale (a few metres to a few kilometres) dynamics of ocean events.

6. CONSIDERATION BY ACMRR

The previous sections have outlined some of the fishery problems for which research involving more than scientists usually working in fishery institutions is needed. Suggestions have been made as to those problems - energy flow, especially in relation to multi-species fisheries and stock/recruitment - which presently deserve priority attention. The Committee should, therefore, first consider whether those are the right questions to be given priority, or whether they should be modified or others substituted. For example, more attention might be given to questions of medium-term (one or two decades) fluctuations in fish stocks, especially in species of particular commercial interest. (In this connexion, it must be stressed that almost any research into the marine environment could, in the long-run, have significant pay-offs for fisheries, and that a listing of all research topics that could be useful will not be helpful in guiding research into those lines where results useful for fisheries are most likely.)

The Committee should then consider how these questions (modified as necessary) should be tackled. Clearly they are not easy to answer, and answers will take considerable research effort. Undoubtedly one valuable action the Committee can take is to draw the attention of the scientists outside fisheries to the potential practical value of certain lines of research. Another action that has been found productive is the establishment (probably jointly with other interested organizations) of working parties that can examine a problem in greater depth than is possible for the Committee as a whole. The Committee is, therefore, invited to determine what topics (if any) could usefully be examined by a working party, what other organizations (e.g., SCOR, IABO, etc.) should be invited to collaborate and to prepare detailed terms of reference.

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Appendix 1

WORLD CLIMATE CONFERENCE: INFORMATION BULLETIN FOR OVERVIEW SPEAKERS

by

R.M. White
Chairman of the Organizing Committee

The World Meteorological Organization (WMO) has taken the decision to convene a World Climate Conference - A Conference of Experts on Climate and Mankind - during the period 12-23 February 1979, at the WMO Headquarters in Geneva, Switzerland. The decision of the WMO, in association with United Nations Environment Programme (UNEP), Food and Agriculture Organization (FAO), United Nations Educational, Scientific and Cultural Organization (Unesco) and World Health Organization (WHO), stems from the growing world concern about the impacts of climatic change and variability on the economy and welfare of all nations. The impacts of climatic change upon various sectors of the economy need to be better understood, and there is a need to consider steps that might enable nations, individually and collectively, to respond more effectively to adverse climatic changes.

WMO is now in the process of developing a World Climate Programme (WCP) in conjunction with a number of other international, intergovernmental and nongovernmental organizations. As part of this process, the World Climate Conference (WCC) is being convened to provide a definitive assessment of the impact of climate change upon human activities, and to define courses of action that might be taken to mitigate their impact. There have been many scientific and technical conferences on the physical and geophysical aspects of climatic change and variability. The World Climate Conference will, therefore, seek to build upon our present knowledge and understanding of climate change, focusing principally upon the social and economic impacts of natural and manmade climate changes. The World Climate Conference is expected to provide the most definitive and comprehensive assessment of the impact of climate on human activities ever attempted.

WMO, in conjunction with other international agencies and nongovernmental organizations as well as other experts invited in their personal capacities, has formed an Organizing Committee for the Conference. The Organizing Committee is under the chairmanship of Dr. Robert M. White, Chairman of the Climate Research Board of the U.S. National Academy of Sciences. Dr. White has also been designated as Chairman of the Conference. Dr. White will be assisted by a small Bureau of the Organizing Committee, consisting of Prof. J.C.I. Dooge, Department of Civil Engineering, University College, Ireland and Prof. Ju. Sedunov, Deputy Director, Hydrometeorological Service of the U.S.S.R. This Bureau will also be assisted by Prof. F. Kenneth Hare, Director of the Environmental Research Institute, University of Toronto, Canada.

The Organizing Committee has held two meetings and has agreed that the WCC will address the series of topics as outlined in the Appendix to this note. During the Conference, overview reports will be presented by selected speakers for each of these topics during the first week. These reports are intended to be comprehensive reviews of the state of knowledge in each topic as well as of the individual views of the speaker. The overview reports are also intended to define the specific issues that will be discussed by the Conference. The overview papers will be delivered at plenary sessions with adequate time in each session for a discussion of the issues and of the factual material.

During the second week, the World Climate Conference will be organized in a series of working groups, which on a more detailed level, can come to grips with the issues identified in the overview papers. These working groups will be asked to make recommendations on each of the issues that have been raised. Recommendations may call for a variety of actions by governments, international organizations or other groups, to tackle the problems defined by the overview papers. Reports of the working groups will be presented at the end of the Conference to a plenary session for adoption by the Conference.

The conclusions, recommendations and actions suggested by the Conference will be of particular value, and lay the basis for action by the WMO Congress which will meet in April 1979, some two months later. The Executive Committee of WMO felt that the Conference should address the crucial question as to whether the problems identified during the meeting are of sufficient weight and importance to require the convening of another conference at ministerial level.

The Conference, which will last for two weeks, will be a conclave of experts. All speakers and participants will be by invitation only, for the expertise that they can bring to the deliberations. The Organizing Committee will ensure that participants at the Conference are geographically representative of all areas of the world. There will be a maximum of 120 participants. The Executive Committee of WMO felt that WCC should not be just another meteorological conference. Rather, the WCC will be a Conference of experts convened to examine the impact of climate on the various economic sectors and other aspects of human activity. For this reason, the participants will be predominantly non-meteorologists, and experts from various fields.

Because of the nature of the Conference, it is expected that all overview speakers, session chairmen and participants will be working members of the Conference. They will participate in the discussions at the plenary sessions, in the working groups, and in the formulation of recommendations.

The topics on which overview papers will be prepared fall naturally within the interests and expertise of many different international organizations. The Conference, therefore, is regarded as a collaborative effort among the international bodies concerned.

Sessions dealing with agriculture, forestry and fisheries will be organized in close collaboration with FAO. Unesco has agreed to participate actively in the sessions dealing with global ecology and marine resources. WHO will assist in the selection of authors and the organization of sessions dealing with climate and health. UNEP, having a broad interest in all topics, has agreed to provide support for many sessions and activities of the WCC.

To assist the overview speakers in the preparation of their material, WMO and the other participating organizations are prepared if necessary to provide support to enable them to interact with a small group of specialists in their fields and to ensure contributions to the preparation of overview papers from diverse groups.

It will be necessary to arrange for interaction and coordination between the overview speakers as they prepare their reports. To this end, the Organizing Committee has planned a meeting of the overview speakers from 24 to 28 April at the International Institute for Applied Systems Analysis, at Laxenburg, Austria. This meeting of the Overview Speakers will seek an early exchange of information on the proposed context of the overview reports and an identification of issues. The meeting of Overview Speakers will be held in conjunction with an International Workshop on Climate Issues, to be convened by the Climate Research Board of the U.S. National Academy of Sciences. In this way, the overview speakers will have the benefit of the comments of, and interaction with, the members of the International Workshop.

The Organizing Committee has proposed that the World Climate Conference issue two different publications. The first will summarize the Conference findings and recommendations and and will be published immediately after the Conference for distribution to the WMO Congress. It is intended that the overview papers themselves will be published as preprints so that they will be available to all Conference participants, and later assembled into a volume of comprehensive Proceedings of the World Climate Conference. It is hoped that the WCC Proceedings will be the definitive work on the range of climatic issues considered by the Conference. It will be a volume that can serve as a basis for planning the World Climate Programme at international and national levels.

The following timetable is proposed for the guidance of the authors:

- Authors of the overview papers will be contacted in the beginning of January 1978
- Authors are requested to prepare an outline of their papers and send this to the Secretary-General and the Chairman in early April 1978
- A coordination meeting will be held in Laxenburg from 24 to 28 April 1978. During this meeting the authors of the overview papers and the Chairman of the Organizing Committee will exchange ideas and identify issues
- Full text of the papers (approximately 20-30 pages) should be ready by August/September 1978. These papers will be reproduced and distributed as pre-Conference documents in their original version
- An abridged version of each paper (approximately 10-15 pages) should be prepared by each author and be ready by August/September 1978. These abridged versions will be translated into all WMO official languages and distributed as pre-Conference documents.

Appendix 2

CLIMATIC VARIATION AND FISHERIES

Draft Outline by D.H. Cushing

1. INTRODUCTION

Most fisheries are variable, many highly so. This variation may be shown in abrupt year-to-year variations in catches, or in changes of much longer periods, of decades or more. The proximate causes of many of these fluctuations are changes in the number of young fish surviving in different years (year-classes). Year-class strength in some stocks has been known to be connected with the width of annual rings in pine trees in adjacent land areas; the year-classes of stocks over wide areas have also been shown to show similar fluctuations. These relationships suggest some fundamental link, associated with some aspects of climate, in a broad sense.

2. SOME EFFECTS ON FISHERIES

We have to depend to a large extent for our knowledge of the fluctuations of fish stocks on the records of commercial fisheries. Except for the most recent years, these records are effectively limited to the temperate waters close to the developed countries of the North Atlantic and North Pacific. Our knowledge of fishery fluctuations, particularly of long periods (of several decades upward) is limited to those areas. In these areas several stocks show very marked fluctuations. For example, the records of the Norwegian and Swedish herring fisheries, which go back several centuries, show several cycles during which the fish entirely disappeared from their traditional grounds, with a periodicity that can be linked with those of Japanese and Adriatic sardines.

The recent period of warming in northern temperate areas, which seems to have peaked around 1945, has had its effect on fisheries. Most noticeable has been the establishment of a substantial cod stock at Greenland (which is now well below its peak abundance). Other events have been a general penetration of high latitudes by a wide variety of species, and complete changes in the dominant species in the western English Channel.

Fluctuations of shorter periods are apparent in all areas. Best known is probably the failure of the Peruvian anchovy, linked with "El Niño", a very large-scale oceanographic and climatic phenomenon. Elsewhere the catches of oil-sardine and mackerel off India fluctuate widely, from over a quarter of a million tons to a few tens of thousands. In temperate waters year-classes of the same stock can differ by two orders of magnitude.

3. PHYSICAL BACKGROUND

The success or failure of a year-class seems to be largely related to events early in the fishes' life, principally the food supply. This is clearly linked with the magnitude of primary production; this, in turn, is governed largely by variation in wind strength and direction, at least in temperate waters and perhaps also in upwelling areas (which between them account for most of the world's biggest fisheries). We are, therefore, interested in secular differences in such factors - as well as the more obvious solar radiation. In order to describe such changes, we need to understand the generation of Rossby waves and their modification by the North American land mass as the climate in the North Atlantic is affected: in general, long-time series of catches are more available in that ocean than elsewhere. For the same reason, we need to describe the ST anomalies in sea-surface temperature in the North Pacific, that is, the very extensive patches of unusually warm (or cold) water that modulate the climate in a conservative way.

Such events vary in time and there are long-term trends in wind strength and direction expressed, for example, as the number of days of general westerly circulation over the British Isles for a century or so. Such periods are of interest to fisheries biologists.

4. THE LINKS BETWEEN CLIMATE AND FISH STOCKS

Although it is clear that climate, in a general sense, affects fish stocks, the nature and mechanisms of the relation are not well understood. Attempts at direct empirical correlation between environmental factors and year-class strength have seldom been successful because of the wide choice of factors and the limited number of observations (usually only one pair per year). It seems that we will need a deeper understanding of the various biological and physical events in the ocean and their links to the factors directly controlling year-class strength. One promising hypothesis being investigated is based on the observation that, in temperate waters, the spawning of fish and the basic production of plants and small zooplankton are both highly seasonal. The survival of a brood of fish may, therefore, depend on the degree to which its peak demand for a certain type of food is matched to the peak abundance of that food.

Appendix 3

EL NIÑO

Draft Outline by D.H. Cushing

1. INTRODUCTION

Periodically, off Peru, just after Christmas, the upwelled cool water at the surface is replaced by warmer water from the north. Then the anchoveta become harder to find, the plankton is less rich and the guanay birds fly south. The El Niño from February 1972 to 1973 had a disastrous effect upon the anchoveta fishery for catches were reduced by a factor of 3 or 4 and it has not since recovered. The link between El Niño and the fishery is not understood, but the physical event itself is related to panpacific events in the atmosphere and ocean. The biological consequences in the waters off Peru have been well recorded but not understood.

2. HISTORY OF "EL NIÑO"

In pronounced form there have been about half a dozen El Niños in the present century, but there have been more frequent events of less marked character. The period of warm coastal water is usually associated with somewhat calmer conditions and heavy rainfall. The original commercial interest was in the guano production, records of which extend back for some decades; during the sixties the predominant interest was in the anchoveta fishery.

3. PHYSICAL BACKGROUND

The upwelling system depends on southerly winds, under the influence of which cold water is drawn from 100–200 m and drifted offshore. Within 50 km from the shore the dynamic boundary, there is a northbound Peru coastal current which is effectively the region of coastal upwelling. Offshore the Peru oceanic current which also flows to the north, is a region of offshore divergence. Between them flows a subsurface countercurrent and below the coastal one flows an undercurrent.

El Niño is a warm salty layer which extends south over the Peru current, accompanied by heavy rain. Bjerknes (1961) associated it with atmospheric changes that cause a trans-equatorial flow from the Equatorial Countercurrent. During a period of intense southeast trades, water is assumed to accumulate in the western Pacific and when they relax the water should flow back into the eastern Pacific in the Countercurrent and perhaps also in the Undercurrent and the South Equatorial Countercurrent. The occurrences of El Niño have been correlated with anomalies in atmospheric pressure difference between Darwin and Easter Island. El Niño occurs when the difference is low when the trades have relaxed.

4. THE BIOLOGICAL EVENTS IN 1972-73

In February 1972 a very pronounced El Niño started and lasted for about 18 months and during this period the 1972 and 1973 year-classes of anchoveta were very much reduced as compared with their predecessors. Further, that of 1971, hatched some months before the El Niño, was also much reduced; however, there were some abnormal events during 1971, some warmer water in the south, more intense upwelling in early spring and delayed maturation in the anchoveta, and it has been suggested that they signalled in advance the arrival of El Niño.

A relatively large number of exotic animals appeared off Peru with El Niño. They were mainly fishes from the Central American region and even from California, but the most spectacular was the first appearance in the eastern Pacific of the milkfish, *Chanos chanos*, which may have crossed the ocean in the Equatorial Countercurrent.

The number of guanay birds was reduced by the El Niño of 1957-58, but by 1962 they had recovered. In the next notable event, 1965-66, the numbers again declined but did not recover. In 1972-73 the numbers of birds fell yet again and as yet they have not recovered, remaining at a low level.

The anchoveta population suffered considerable changes during the El Niño of 1972-73. Not only was the recruitment reduced considerably, but the survivors appeared to live longer and grow larger. Catches of up to 3 million tons have been sustained since 1972 (as compared with 10-12 million tons before that date) and the increase in growth and survival under such conditions are remarkable.

THE SCIENTIFIC WORK OF REGIONAL BODIES

by

The FAO Secretariat

1. INTRODUCTION

The work of regional fishery bodies is scheduled as a major item on the agenda of the Committee on Fisheries (COFI) at its session immediately following ACMRR. The paper prepared by FAO for COFI is provided as Appendix 2 to this note; this sets out FAO's views on possible activities of these bodies, and how they might be funded and supported. It is not necessary to repeat the points made in the COFI paper, except to draw attention to those matters on which the views and comments of ACMRR would be useful to COFI and to FAO. These fall into two main groups - the definition or clarification of the scientific activities and responsibilities of the regional bodies, and the support required if they are to discharge these responsibilities effectively.

2. SCIENTIFIC FUNCTIONS

In another paper (see pp. 1-4) the difficulties of scientific research in developing countries were discussed, and it was pointed out that, for the foreseeable future, many developing countries would initially have only limited national research capabilities. They would have to rely, to a greater or lesser extent, on outside assistance and collaboration with other countries to acquire the necessary scientific information on which to make policy decisions regarding the development and management of their fisheries. The regional bodies clearly have a key role to play in this, particularly in relation to the Technical Cooperation among Developing Countries (TCDC) concept. This role can range from the simple exchange of scientific information e.g. concerning the migrations or food habits of a species of fish occurring widely in the region, to the provision of specific and detailed advice on the measures needed to manage a stock of regional interest. To the extent that the number of stocks occuring wholly within the jurisdiction of a single country has been reduced by extentions of national jurisdiction, the latter aspect might have been expected to decrease in importance. However, it may be noted that (a) many stocks are, even with extended jurisdiction, shared between several countries, (b) the number of stocks, especially among those fished by developing countries, which are heavily fished has grown, so that the absolute number of stocks requiring regional management is probably increasing, and (c) countries may find that it is convenient to seek advice from a regional body even in respect of a stock wholly within their jurisdiction (as Canada has from the International Commission for the Northwest Atlantic Fisheries (ICNAF)), bearing in mind that the decisions arising from the advice will remain a national prerogative.

The scientific advisory functions of regional bodies has been discussed previously by ACMRR and one of its working groups (see especially Supplement 1 to the report of the seventh session). The earlier conclusions need not be elaborated here, though ACMRR may wish, for the convenience of FAO and COFI, to note its earlier conclusions hold good, or whether changing circumstances call for modifications. This would be particularly useful in respect of the funding needed for the secretariat or a regional body if it is to fulfil adequately its scientific advisory functions.

The recent experience of FAO bodies in this field has underlined the importance of specialist assessment working groups. Considerable progress has been made by some of these regional groups, for example in the CECAF, GFCM and WECAF areas, but this progress has revealed that to obtain the detailed results needed for advice, it is desirable to have

groups with less wide responsibilities, concerned only with certain stocks but able to examine the data for these groups in some detail. Specialist groups are examining several of the CECAF stocks (hake, shrimp in the southern part of the area, etc.). While it may not be necessary, at least for some time, to have in any of the FAO bodies, as many separate working groups as there are in the ICES (International Council for the Exploration of the Sea) area, it may be necessary to increase considerably the existing number of groups. ACMRR's views on this would be useful, particularly bearing in mind the general policy of the organization to reduce the number of FAO meetings (see paragraph 26 of Appendix 2[1]).

At the other extreme, concerning the informal exchange of general information on research ideas, work in progress, and results, FAO bodies have not been as successful or active as, for example, ICES. One reason is that distances and costs prevent these bodies providing the kind of informal semi-social gathering of scientists which is provided by ICES. Other means of disseminating ideas and information are needed. Newsletters or other documentation provided by the secretariat are an obvious medium, and IPFC has recently started such a newsletter. Advice from ACMRR would be welcome as to whether such a regional newsletter could in principle be useful, and if so, how it could become so in practice. For example, how will those preparing such a newsletter become aware of the research activities - particularly those not apparently in published reports - that are significant to the region? Can anything be useful centralized at a global level?

3. SUPPORT TO REGIONAL BODIES

The support that regional bodies need if they are to discharge their responsibilities is discussed in the annex, which describes inter alia the support (other than staff time) provided by FAO - this covers mainly meeting costs, e.g. interpretation, etc. (see Annex 1 of Appendix 2) and the budgets and staffing of many of the independent bodies (see Annex 2 of Appendix 2).

ACMRR itself, in its report on regional bodies has carefully examined the basic secretariat requirements and its conclusions, as set out in the supplement to the report of its seventh session, are given in Appendix 1.

It might be useful for ACMRR to review these conclusions and to advise on whether they are still valid, or might need modifications. For example, the probable need for additional working groups has already been noted - and probably, as more management and development decisions are taken on the basis of these groups' results, they may also have to meet more frequently. In addition, the experience of these groups has shown the importance, given the present level of expertise in many developing countries, of active participation in these groups (and in the preparatory and follow-up work) of experienced and competent scientists from outside the region. ACMRR is invited to comment on how much support is likely to be needed, and the extent to which it can be provided by Regular Programme staff, staff or consultants from the regional projects, etc.

1/ Appendix 2 is not re-published here. It is the paper COFI/78/5 "Future of FAO Regional Fishery Bodies" presented at the Twelfth Session of the FAO Committee on Fisheries, Rome, 12-16 June 1978.

APPENDIX 1

DRAFT BUDGET FOR A REGIONAL FISHERIES BODY

Here is given a tentative list of the total funds required annually to ensure that the regional fisheries bodies associated with FAO (CARPAS, CECAF, GFCM, IOFC, IPFC, EIFAC and CIFA) can carry out the minimum basic tasks required for the provision of scientific advice to these bodies on questions of fishery development and management. It has been assumed that the relevant activities of all the bodies would be carried out centrally by FAO; if they were carried out by each body separately the total costs would be slightly higher.

The activities that should be carried out by the secretariat that need financing include the following:

1. Compilation of data (a) catch
   (b) effort/c.p.u.e.
   (c) size/age composition

2. Direct requests and make visits to countries (not necessarily developing ones) to improve supply of data.

3. Some preliminary analysis of data by routine methods.

4. Arrangements for meetings of expert working groups, and payment of travel of some participants.

5. Participation by expert commission staff in activities of working groups.

6. Provision of some fellowships.

Requirements

Duties			
General	Director plus fellows	28 000*	28 000
1-2 (a) catches	Technical and clerical staff	84 000	
	Computer	50 000	
	Travel	10 000	144 000
(b) effort	Same as (a) + 50 percent		216 000
(c) size/age	Same as (b)		216 000
	Publications		20 000
3-5	Professional and clerical staff		70 000
4	10 meetings (travel of some participants)		80 000
6	4 Junior Fellows		60 000
	Secretarial support, incidentals, etc.		60 000
		TOTAL	894 000

* Costs as at 1.1.73

PROMOTION OF AQUACULTURE RESEARCH AND DEVELOPMENT THROUGH THE ESTABLISHMENT OF AN ADVISORY PANEL ON AQUACULTURE

by

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1. INTRODUCTION

At the FAO Technical Conference on Aquaculture held from 26 May to 2 June 1976 at Kyoto, Japan, the need for expanded international and bilateral assistance for aquaculture research and development was realized. Considering that the best available international expertise and experience should be brought to bear on the formulation and implementation of research and development projects and on the coordination of worldwide activities, the Conference recommended that FAO, in cooperation with other agencies concerned, establish an "Advisory Panel on Aquaculture" to facilitate the implementation of the recommendations of this Conference and to advise on future aquaculture activities on a continuing basis. As a special example of a successful advisory instrument within the framework of FAO, mention was made of the "Expert Panel on the Facilitation of Tuna Research" which was set up after the World Tuna Conference held in 1962 at La Jolla, U.S.A. In the following, some aspects of this proposal are analysed.

A first draft of this paper has been distributed among the aquaculture experts listed in Appendix 1. Their numerous comments especially on the list of key areas in which advice is needed and which is given under Section 4, have been largely considered in the present form of the paper. The author wishes to express his gratitude for the assistance received.

2. EXISTING ADVICE TO AQUACULTURE RESEARCH AND DEVELOPMENT

2.1 Regional Fisheries Bodies

Research activities in the field of aquaculture are widely scattered throughout the world. EIFAC and ICES have recently reported on the present research activities in this field within their member countries (Tiews, 1973; Tiews, 1977).

At present, in the 18 member countries of ICES, there are more than 900 scientists and technicians employed in the field of mariculture working in roughly 100 research institutes engaged in mariculture research. At least half of them have been trained as scientists. The report does not include information on the personnel involved in the U.S. National Sea Grant projects nor are research projects of the industry mentioned. In the EIFAC report, which dates back to 1973, the work of 57 institutes from 21 European countries has been compiled. At that time there were roughly 300 scientists and 300 technicians employed in the field of aquaculture at least on a temporary basis. Although there is a certain overlapping in the description of the work within both reports, it can be concluded that today perhaps more than 1 500 scientists and technicians are working in the field of aquaculture in Europe and North America.

Regional advice to aquaculture research and development is given by EIFAC, ICES, GFCM and IPFC (for acronyms see Appendix 2). In EIFAC its Subcommission II, being one of the three Subcommissions, is dealing with fish culture and fish diseases. Several symposia, workshops and working parties were organized to deal with various aspects of aquaculture

research and development in the fields of fish nutrition, fish feed technology, the control of the major communicable fish diseases and the controlled reproduction of freshwater fish species. Since 1972 a Cooperative Programme of Research on Aquaculture dealing with fish diseases and later with fish nutrition was organized. In June 1978 under EIFAC a "Symposium on Finfish Nutrition and Feed Technology" will be held in Hamburg supported by ICES, GFCM and IUNS.

Under GFCM a Working Party on Aquaculture and Fisheries in Brackish Water existed from 1969 to 1974. A Symposium on Aquaculture in Brackish Water was organized in 1972 and a Cooperative Programme of Research in Aquaculture as an intermediary for the execution of the GFCM programme in this field has been promoted.

Under IPFC two working parties were set up to deal with coastal aquaculture and environment and with the economics of aquaculture. A Symposium on Coastal Aquaculture was organized in 1970. In 1972 a Scientific Technical Session on Coastal Aquaculture and Environment was held.

Under the non-FAO Fisheries Bodies, in ICES a Working Group on Mariculture was set up in 1974, which dealt, until its discontinuation in October 1977, with the general research situation in this field within the Council's member countries, the methodology involved in the development of fish feeds, and the methodology of mass rearing of broodstock and of juveniles of mariculture species for controlled farming and for ocean ranching. Aquaculture topics were also dealt with regularly at the Statutory Meetings of the Council in the Fisheries Improvement Committee, the Shellfish and Benthos Committee and the Anadromous and Catadromous Fish Committee. In 1977 a Mariculture Committee, being one of the 12 scientific committees of the Council, was set up to replace the Working Group on Mariculture. This Committee will keep under review and coordinate investigations relating to culture of marine organisms, including transplantation and introduction of new species.

2.2 ACMRR

ACMRR discussed at its 6th Session in Rome in March 1971 the improvement of marine resources and mariculture, including the transplantation of marine organisms. At that time a Technical Conference on Aquaculture was recommended for the first time to the Director-General, which finally took place in May 1976 in Kyoto. At the same Session the Committee recommended that the establishment of the ACMRR/IABO Working Party on Aquaculture, which met once from 17 to 24 May 1972 in Rome to review the recommendations of recent meetings pertinent to aquaculture particularly those of the IOC-GELTSPAP Meeting (November 1970) and the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing (December 1970) and to assist FAO and the other organizations concerned in designing regional and international research programmes in aquaculture in the estuarine and marine environments and their application to national development programmes. This working party reviewed the present status of problems of shrimp, marine fish and mollusc culture, discussed the effects of pollution on aquaculture, the polluting and other adverse effects of aquaculture activities, the use of organic waste and waste heat for aquaculture, the resource improvement through seeding, the reasons for slow progress in aquaculture research, regional and international cooperation in aquaculture research, high priority problems for cooperative research and projects for inclusion in LEPOR and the role of FAO in promoting aquaculture research. Furthermore, it planned the FAO Technical Conference on Aquaculture.

At its 7th Session in October 1973, ACMRR considered the future role of the ACMRR/IABO Working Party on Aquaculture and agreed that it should continue with the following terms of reference:

(i) In cooperation with the FAO regional bodies concerned to review the results achieved by Cooperative Research Programmes on Aquaculture and to assist in the pooling of experience and exchange of information;

(ii) Consider ways and means for better utilization of the facilities of academic institutions for ecological and physiological studies related to aquaculture;

(iii) Assist ACMRR in preparing a world inventory of existing potential aquaculture sites with realistic projections of possible increases in fish and shellfish production through farming;

(iv) Review the present status of introductions of non-indigenous species for aquaculture and transplantations and develop suitable guidelines for future work in this field, including the procedures to be adopted for determining the need and testing the results of such activities;

(v) Along with other experts to assist FAO in the planning and organization of the proposed FAO Technical Conference on Aquaculture, and

(vi) Continue to assist in providing guidance for scientific programmes on basic research relevant to the aquaculture aspects of LEPOR and related activities under IOC.

The membership should be revised as necessary to fulfil the new functions.

At the 8th Session of ACMRR in September 1975 in Portugal the Committee proposed to review the task of its Working Party on Aquaculture which did not meet a second time, and to hold it in suspension until after the FAO Technical Conference on Aquaculture.

2.3 FAO/UNDP Aquaculture Development and Coordination Programme and others

As part of the activities of the FAO/UNDP Aquaculture Development and Coordination Programme, a series of planning workshops was held in Africa, Asia and Latin America in 1975. A detailed review of research needs in aquaculture with particular reference to the needs of developing countries was made by a Working Group on Aquaculture appointed by the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR), which met once in 1973 in Spoleto, Italy. A TAC Sub-Committee on Aquaculture prepared specific proposals for international research in the field of aquaculture (TAC, 1974), including the establishment of coordinated regional networks of aquaculture centres for research and training in Asia, Africa and Latin America (Pillay, 1976).

In 1973 the Southeast Asian Fisheries Development Center (SEAFDEC) established an Aquaculture Department which is hosted by the Government of the Republic of the Philippines and has established research and training programmes in aquaculture.

The International Center for Living Aquatic Resources Management (ICLARM) in Manila, which is an international, non-profitmaking, scientific centre created to carry out research and stimulate discussion and the flow of information on fisheries and other living aquatic resources relevant to meeting the nutritive, economic and social needs in economically developing countries, also includes aquaculture in its research activities. Its Program Advisory Committee identified at a recent meeting in Manila several fields of aquaculture in which the centre intends to carry out research programmes (ICLARM, 1977).

The International Foundation for Science in Stockholm (IFS) is sponsoring among others, grants for aquaculture research and development projects in economically developing countries throughout the world. At present some 50 aquaculture projects are promoted in Asia, Africa and South America by grants each in the order of approximately U.S.$ 8 000-12 000 given to individual research scientists.

2.4 Aquaculture Societies

The World Mariculture Society, the European Mariculture Society and the newly-established Latin American Aquaculture Society are rapidly growing and have turned out to be very important sources of advice for aquaculture development. Other regional societies are in preparation. They are to promote contacts between all involved or interested in mariculture, to facilitate the circulation of mariculture information, to promote the sponsorship of multidisciplinary research in mariculture, and to make possible better cooperation among governmental, scientific and commercial organizations and individuals on matters dealing with mariculture. They are holding annual meetings with important lecture programmes. Under the World Mariculture Society several "Task Forces" on nutrition, genetics, health and sanitation, standards, etc., were set up and have met several times.

It is the ultimate aim to integrate the regional societies into an International Federation of Aquaculture Societies (IFAS), which will be apolitically organized and managed exclusively by the professional scientists whose professional purposes it will be designed to serve.

2.5 FAO Technical Conference on Aquaculture

A milestone in the promotion of aquaculture research and development was the FAO Technical Conference on Aquaculture held in Kyoto, Japan, in 1976. It was attended by 308 participants and 154 observers from 38 countries and 10 international, intergovernmental and nongovernmental agencies (FAO, 1976).

One of the major conclusions of the Conference was that the pace of future development would depend on the priority given to aquaculture by governments funding and financing agencies and the industry. The session, therefore, adopted the "Kyoto Declaration on Aquaculture" in which the encouraging progress in the past decade of aquaculture is stated, and said that realistic estimates place future yields of food at twice the present level (now 6 million tons) in ten years and five times the present level in 30 years, if adequate support is provided. It describes the great importance of aquaculture as a means to revitalize rural life, to supply products of high nutritional value, to provide intellectual challenge to skilled professionals of many disciplines, to provide for sound investment of money, materials, labour and skills, and that it can be practised in all countries, coastal and landlocked, developed and developing. From this, the Conference concluded that aquaculture merits the fullest possible support and attention of national authorities for integration into comprehensive renewable resources, energy, land and water use policies, and that it could benefit greatly from support and assistance from international agencies which should include the transfer of technology actively planned and executed, with research carried out in centres representing various regions.

The Conference arrived at various conclusions on specific aspects and indicated future lines of action. Major recommendations in furtherance of the policy implicit in the above declaration for implementation by governments and concerned agencies dealt with the questions of pilot-scale projects, the expansion of aquaculture production, the inclusion of aquaculture in integrated rural development projects, the production and distribution of aquaculture inputs, the establishment of extension services, training of core personnel for aquaculture development, aquaculture legislation, aquaculture research, and the establishment of an Advisory Panel on Aquaculture (FAO, 1976).

3. WEAKNESSES OF PRESENT STATUS OF AQUACULTURE ADVICE

The main weakness of the present situation is the obvious lack of coordination between the various sources of advice. It could be relatively easily overcome, if at least an "Intersecretarial Working Group" of the fisheries bodies engaged in aquaculture research and development would be established, in order to promote: (a) interregional cooperation in aquaculture research and development including the exchange of information on all decisions made regarding aquaculture; (b) exchange of aquaculture publications of the respective fisheries

bodies; (c) exchange of aquaculture bibliographies from the member countries prepared by the bodies, as well as (d) administrative reports on the progress of individual research projects prepared by the member countries and compiled by the bodies. In such a Working Group membership should be open also to the aquaculture societies so that information material will not only be brought to the attention of the Member Governments, but also to the research workers directly. Interregional information exchange on what is going on could be greatly improved by such a group which could work mainly by correspondence.

Another weakness of the system is that much of the work done in the fisheries bodies is of an accidental nature and not necessarily well planned. Many of the conclusions reached do not have the depth which one would like to see, because the necessary expertise for in-depth discussion was often not available. Often the expertise needed is only obtainable outside the region. This was the reason that the Technical Conference on Aquaculture strongly recommended the establishment of a worldwide recruited expert group to give advice on specific key areas of research and development.

4. KEY AREAS IN WHICH ADVICE IS REQUIRED

The following key areas in which advice is needed were identified on various occasions by expert groups:

4.1 Strategy

- Advice on the development of overall strategies and balanced progress in developing aquaculture as well as on fundamental planning in aquaculture

4.2 Specific Research Issues

4.2.1 Research priorities

- Identification of priorities in providing research input to aquaculture development in the developing countries

4.2.2 Methodology

- Evaluation of the needs for the standardization of methodology involved in aquaculture research, and their specification

4.2.3 Diseases

- Review of basic data available on fish and shellfish mortalities, to facilitate diagnosis of disease, and to advise on the formation of a team of experts to be made available at short notice for detailed investigations when mortalities occur

- Advice on the preparation of a series of disease identification sheets for aquaculture species

- Evaluation of the needs and the ways for development of quick methods for the identification of diseases in aquaculture species

- Evaluation of the experience gained regarding immunization of species against diseases, and formulation of research and development programmes

4.2.4 Genetics

- Advice on a cooperative research programme to develop strains of fish which are resistant to specific fish diseases through selective breeding

- Advice on the establishment of gene-pools

- Advice on development of appropriate methodologies and on research requirements for genetic improvement of aquaculture species

4.2.5 Nutrition and diet development

- Advice on cooperative research programmes on nutritional needs of species suitable for culture in particular regions, and on the development of feeds for these species, with special attention to the use of locally-available raw materials

- Evaluation and standardization of methodology involved in nutrition research and application of results into efficient, effective production diets to lower food costs and to improve fish health and quality

4.2.6 Reproduction

- Advice on cooperative research programmes on the reproductive physiology of species suitable for culture in particular regions, and on development of techniques for controlling spawning

4.2.7 Environment

- Evaluation of available knowledge of the effects of pollution on aquaculture activities, on the effects of aquaculture activities on the local environment, and on the control of aquaculture effluents

- Evaluation of the potentials for use of agricultural and other organic wastes in aquaculture

- Evaluation of the potentials for use of heated water effluents

4.2.8 Culture systems

- Evaluation of available knowledge on culture systems for species or groups of species of interest in a particular region

4.2.9 Seeding and transplantation

- Evaluation of methods for determining the value and effects of seeding programmes

- Advice in the design of cooperative research for such evaluation

- Review the present status of transplantations and develop guidelines for future work in this field, including preliminary studies to determine whether transplantations should be undertaken and to formulate procedures to be adopted for successful transplantations

4.2.10 Economics

- Advice on the establishment of research programmes for the evaluation of the economic viability of ongoing and proposed aquaculture projects

4.2.11 Extension service

- Advice on the methods of establishing and conducting services for transmitting information to fish farmers and aquaculture field workers

4.3 Symposia and Workshops

- Evaluation of the need to convene scientific symposia and technical workshops for the speedy advancement of aquaculture science and development, and specification of the terms of reference for these

4.4 Research and Development Centres

- Evaluation of the need to establish regional research and development centres for aquaculture, and formulation of their organization and tasks

- Advice on the establishment of a pituitary bank to ensure adequate supplies for experimental and seed production programmes in developing countries

- Advice with the assistance of existing Ingredients Data Banks on linear programming computerization of information available on composition, nutritive value, and cost of available feed ingredients for the formulation and manufacture of feeds in developing countries, and to recommend standard methodologies for the assessment of these

4.5 Manuals, Inventories

- Advice on the preparation of an aquaculture legislation manual to be used by countries wishing to enact legislation to facilitate the establishment of aquaculture industries and to zone coastal and inland areas for aquaculture

- Preparation of a world inventory of existing and potential aquaculture sites, with realistic projections of increases in fish and shellfish production through farming

- Advice on the preparation of a manual series describing the biology and culture of the various aquaculture species

- Advice on the preparation of a multilingual dictionary of aquaculture

4.6 Training

- Advice on training programmes for the core personnel for the proposed regional network of aquaculture centres

4.7 Cooperation

- Advice on the most effective means for interregional cooperation in aquaculture research and development

4.8 Pilot Projects

- Specification of pilot projects to test the technical and economic viability of new techniques in aquaculture, including site selection for such pilot projects

4.9 Aquaculture Standards

- Advice on the establishment of international aquaculture standards

This list is provisional and by no means complete.

5. CONCLUSIONS

It remains to be decided if a new Advisory Panel on Aquaculture under the Director-General of FAO to be set up in cooperation with other agencies will be needed as proposed by the FAO Technical Conference on Aquaculture or, if it is sufficient, at least for the

time being, to revive the suspended Working Party on Aquaculture of ACMRR, to give advice in the different key areas mentioned under Section 4. For the time being, considering the financial situation of FAO, the latter is probably the more suitable solution.

When looking at the key areas listed, it is obvious that the ACMRR Working Party on Aquaculture, if given the task to advise on the various subjects, has to decide at its first session how to cope with its task and probably will assign Ad hoc Groups to deal with certain topics, for which only specialists can give the expected advice. Each group should comprise a small core membership of specialists nominated by the Working Party, of which one might be the designated convenor plus one member of the Working Party who will provide the necessary liaison between the Group and the Working Party.

Each Group may propose changes in its membership subject to agreement by the Working Party member concerned and the chairman of the Working Party. Each group should seek widely whatever advice and consultation it may require. Similar procedures have been adopted for the ACMRR Working Party on Marine Mammals.

When it should be decided to reconvene the Working Party on Aquaculture of ACMRR, the key areas in which advice is needed, as mentioned under Section 4, could be used as terms of reference. At its first meeting, the Working Party should draw up a priority list from the list given and should be allowed to critically comment on this list and, if necessary, expand its terms of reference. In the membership, the liaison to the four fisheries bodies engaged in aquaculture research and development should be sought to guarantee that full use of the work in the bodies can be expected. Whenever feasible, chairmen of important aquaculture working groups or committees should be considered as members of the Working Party.

However, in order to make the Working Party more effective than it has been, it would have to have sufficient resources so that sub-groups could be established and modest operations supported to accomplish some of the most urgent tasks among those listed in Section 4.

The first step in deciding whether an advisory committee on aquaculture can be established, and if so, what form it should take, is to determine whether a commitment can be obtained from FAO, UNDP or some other agency to support this effort.

The next step would be to have the Working Party (or Panel) determine the priorities among the many activities listed and create its sub-groups to start work on these.

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Appendix 1

AQUACULTURE SPECIALISTS CONSULTED

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Appendix 2

LIST OF ACRONYMS USED IN THIS PAPER

ACMRR	Advisory Committee on Marine Resources Research
CGIAR	Consultative Group on International Agricultural Research
EIFAC	European Inland Fisheries Advisory Commission
GELTSPAP	Group of Experts on Long-term Scientific Policy and Planning, Unesco
GFCM	General Fisheries Council for the Mediterranean
IABO	International Association for Biological Oceanography
ICES	International Council for the Exploration of the Sea
ICLARM	International Center for Living Aquatic Resources Management
IFS	International Foundation for Science
IOC	Intergovernmental Oceanographic Commission
IPFC	Indo-Pacific Fisheries Council
IUNS	International Union of Nutritonal Sciences
LEPOR	Long-term and Expanded Programme of Oceanic Exploration and Research
SEAFDEC	Southeast Asian Fisheries Development Center
UNDP	United National Development Programme

BRIEF REVIEW OF WORKING PARTY PROGRESS

by

The FAO Secretariat

1. ACMRR WORKING PARTY ON MARINE MAMMALS

The Working Party, set up in 1972, completed its task in 1977. It has worked with the assistance of four Ad hoc Groups, which all met at least once and some on several occasions. Many other marine mammal scientists also assisted by providing data, preparing documents, attending meetings of subsidiary groups and otherwise. The work culminated in the Scientific Consultation on the Conservation and Management of Marine Mammals and their Environment, held in Bergen, Norway, 31 August to 9 September 1976 and attended by nearly 200 specialists which reviewed the reports of the Ad hoc Groups and other background material. The reports of the Ad hoc Groups and the comments of the Consultation provided the basis for Sections 2-7 of the Working Party's report (ACMRR:9/78/Inf.10). Section 8 contains the recommendations of the Working Party.

The Working Party's report has been published as FAO Fishery Report No. 194. The report is also being published, together with the background material, in FAO's Fisheries Series No. 5. This will contain, in addition to the report, the Proceedings of the Bergen Consultation, a set of Pinniped species summaries, a special section on Sirenia, and the selected papers submitted to the Bergen Consultation. The Working Party further prepared a working paper entitled "Programme of Research Relating to Marine Mammals", published as FAO Fisheries Technical Paper No. 177, for limited distribution. This working paper contains a set of research proposals, worked out in greater or lesser detail, to assist interested bodies to prepare their own research programmes in accordance with their own objectives and priorities.

The Working Party report has been studied by members of ACMRR and their detailed comments have been made available by FAO. The observations of the Chairman of ACMRR are contained in his letter to the Director-General of FAO, Mr. E. Saouma, accompanying the transmittal of the report.

The Working Party has now finished its work, and ACMRR is invited to make comments on the report and its recommendations and to consider whether the party could now be disbanded.

2. WORKING PARTY ON AQUACULTURE

The Working Party on Aquaculture last met in May 1972. Further activity was held in abeyance pending the results of the Kyoto Conference. The Conference recommended "that FAO, in cooperation with other agencies concerned, establish an Advisory Panel on Aquaculture to facilitate the implementation of the recommendations of this Conference and to advise on future aquaculture activities on a continuing basis"[1/]. A discussion of the future of this Working Party, based on the above recommendations, will take place under agenda item 9 of this session. Activities carried out by the FAO Aquaculture Development and Coordination Programme (ADCP) should also be taken into account.

1/ Page 47, Report of the FAO Technical Conference on Aquaculture

3. WORKING PARTY ON FISHING EFFORT AND THE MONITORING OF FISH STOCK ABUNDANCE

This Working Party was established in July 1974 with the following members: Ø. Ulltang, D.J. Garrod, B.B. Parrish and Loh Lee Low. After some work by correspondence, the Working Party met in Rome in December 1975 as part of the Expert Consultation on Monitoring of Fish Stock Abundance, supported by the United Nations Environment Programme (UNEP). The report of this meeting was issued as FAO Fisheries Technical Paper No. 155 in June 1976 (ACMRR:9/78/Inf.9). This report covered the use of catch and effort data in monitoring abundance, but recognized that in some fisheries (e.g. those using purse-seines) other methods of monitoring should be used, either alone or to supplement c.p.u.e. data.

Accordingly, a member of the group (Ø. Ulltang) was, with the support of UNEP, hired as a consultant to prepare a report on this aspect of stock monitoring. This report was considered by the group by correspondence, and was issued in September 1977 as FAO Fisheries Technical Paper No. 176. It is believed that, taken together, these two reports fulfil the terms of reference of the Working Party, and accordingly it is suggested that the Party should be disbanded.

4. AD HOC GROUP OF EXPERTS ON THE FACILITATION OF ACOUSTIC RESEARCH IN FISHERIES

This Group, established in 1971, has worked largely by correspondence, but the need to compare various methods of target strength measurements led to the first meeting organized by this Group. A working party of eight scientists (J.J. Burczynski, R.E. Craig, K. Johannesson, R.B. Mitson, O. Nakken, B.B. Parrish, R. Shotton and J.J. Traynor) met in Aberdeen in December 1977. The report of this meeting was published recently (ACMRR:9/78/Inf.14). This report covers three different techniques employed for the measurement of target strength. Available data on target strengths of gadoid fish are compiled as a standard base and an attempt is made to standardize units, symbols and terminology. Behaviour of free-swimming fish in relation to target strength and target strength measurement of tropical species were identified as having a high priority among further studies. The latter to be arranged through existing FAO field projects.

The participants in this meeting felt, in the light of their experience, that similar meetings of small groups of experts on narrow topics within the general field of competence of the Ad hoc Group, were very useful, and suggested that they should be held regularly. The activity which should receive early attention from a meeting of a small group would be to work out standardization of terms, symbols, and definitions. The meeting also suggested that a world-wide symposium on acoustics in fisheries, similar to the one held in Bergen (Norway) in 1973, be held in 1980. These suggestions have been circulated to the whole membership of the Ad hoc Group for their comments.

In the meantime, the Group as a whole continues to work by correspondence on general matters concerning acoustics.

5. ACMRR WORKING PARTY ON GOALS AND OBJECTIVES
(supersedes Working Party on Scientific Advice to Fisheries Management and Development Bodies)

At its eighth session, ACMRR recommended that a working party be established with the following terms of reference (paragraph 34, Report of the eighth session of ACMRR (ACMRR:9/78/Inf.16)):

"Critically examine the general concepts relating to the goals and objectives of managing living resources as well as the scientific and technical basis for achieving stated goals. In carrying out its task the working party should:

(i) identify the range of proposed goals;

(ii) their purpose(s); and

(iii) interpret them insofar as they depend on scientific advice."

As part of the preparations for the activities of this Working Party, the secretariat drafted a background paper on this topic, which was circulated to all members of ACMRR (as well as some other scientists), with a view to identifying aspects of this topic which would need further attention in a working party meeting. It was also felt that from the comments of ACMRR members it would become clearer which members, or other scientists, should, in the light of various views expressed, be members of the group. In the event, the comments received did not reveal such deep or important differences of opinion as to merit the costs and time of a special meeting, though the comments also revealed the need for a careful look at the whole question of fishery management in a broad context. In fact, the question is being intensively discussed in various fora, particularly in the light of the changes in the regime of the sea.

It was decided therefore to issue the draft paper with minor revisions (as FAO Fisheries Technical Paper No. 166) and to consider the establishment of a working party with broader terms of reference. The Committee should consider what action to take in respect of the general subject of fishery management.

6. SCOR WORKING GROUP 36 ON COASTAL AND EQUATORIAL UPWELLING PROCESSES (with IABO, IAPSO and ACMRR)

At the Joint Oceanographic Assembly (JOA) held in September 1976, it was decided to disband this Working Group, but to ask a small editorial group to summarize, as a final paper of the group, the findings of the investigations from those upwelling sea areas which have been studied most recently. A meeting of this editorial group for the volume on Physical Oceanography of Coastal Upwelling was held in March 1978.

7. SCOR WORKING GROUP 46 ON RIVER INPUTS TO OCEAN SYSTEMS (with ECOR, IAHS, ACMRR, UNESCO, CMG, IAPSO and IABO)

A favourable decision from the United Nations Environment Programme (UNEP) regarding funding for a workshop on river inputs to ocean systems is expected shortly by IOC and, provided funding is assured by the end of January 1978, the convenor of the Steering Committee (J.D. Burton) expects to be able to organize the workshop in December 1978 or January 1979.

8. SCOR WORKING GROUP 50 ON BIOLOGICAL EFFECTS OF OCEAN VARIABILITY (with ACMRR, IABO and IAPSO)

At the Joint Oceanographic Assembly (JOA) held in September 1976, it was decided to disband this working group. The papers given at the special symposium on "Biological Effects of Ocean Variability" held within JOA summarized the present state of knowledge in this field, and will be published by ICES. The Group will draft a short final report which will take into consideration these papers and the discussion held at the special symposium.

9. SCOR WORKING GROUP 56 ON EQUATORIAL UPWELLING PROCESSES (with IAPSO, IAMAP and IABO)

ACMRR has been invited to co-sponsor the Working Group.

Reports from some of the Working Parties which have been disbanded are made available as information papers of the present session:

ACMRR:9/78/Inf.11 Reports of the ACMRR/IABO Working Party on Biological Effects of Pollutants and the ACMRR/IABO Expert Consultation on Bioassays with Aquatic Organisms in relation to Pollution Problems (FIR/R187)

ACMRR:9/78/Inf.12 Manual of Methods in Aquatic Environment Research
Part 2 - Guidelines for the Use of Biological Accumulators in Marine Pollution Monitoring (a manual of the ACMRR Working Party on Biological Accumulators) (FIRI/T150)

ACMRR:9/78/Inf.13 Manual of Methods in Aquatic Environment Research
Part 4 - Bases for Selected Biological Tests to Evaluate Marine Pollution (a manual of the ACMRR/IABO Working Party on Biological Effects of Pollutants) (FIRI/T164)

The FAO Fisheries Technical Paper No. T151: Indices for Measuring Resources of Aquatic Ecological Systems to Various Human Influences (prepared by the ACMRR Working Party on Ecological Indices of Stress to Fisheries) is out of print.

ACRONYMS

CMG Commission on Marine Geology (of IUGG)

ECOR Engineering Committee on Oceanic Resources

IABO International Association of Biological Oceanography (of IUBS)

IAHS International Association of Hydrological Sciences (of IUGG)

IAMAP International Association of Meteorology and Atmospheric Physics (of IUGG)

IAPSO International Association for the Physical Sciences of the Ocean (of IUGG)

ICES International Council for the Exploration of the Sea

ICSU International Council of Scientific Unions

IUBS International Union of Biological Sciences (of ICSU)

IUGG International Union of Geodesy and Geophysics (of ICSU)

SCOR Scientific Committee on Oceanic Research (of ICSU)

PROBLEMAS DE LAS INVESTIGACIONES PESQUERAS EN AMERICA LATINA

por

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Las investigaciones pesqueras en América Latina, igual que en el resto de los países en vías de desarrollo confrontan dificultades debido principalmente, a la escasez de recursos financieros y de personal científico y a la ausencia en muchos países de una política estable de desarrollo pesquero.

La situación creada con el establecimiento de un nuevo régimen marítimo por parte de la mayoría de los países de la región, requiere de una base de conocimientos sobre el estado en que se encuentran los recursos pesqueros y sus posibilidades de utilización, para lo cual no todos los países se encuentran bien preparados.

Esta situación nueva, sin embargo, sirve de estímulo para las naciones en vías de desarrollo, en el sentido de encontrar en la utilización de los recursos pesqueros de sus zonas económicas una fuente importante para aumentar sus oportunidades.

Influídos por el nuevo régimen marítimo, algunos países de esta región han incrementado sus programas de investigaciones pesqueras, han logrado definir con mayor precisión los objetivos de sus políticas pesqueras y han aumentado su interés en la coordinación de actividades - con los países vecinos, particularmente en programas de investigaciones sobre los recursos pesqueros.

Las organizaciones internacionales están interesadas en apoyar el esfuerzo que realizan los países en vías de desarrollo por fomentar la pesca y aumentar sus beneficios. En este sentido, se destaca particularmente FAO, cuyas actividades se orientan a la formación profesional, la atracción de inversiones hacia el sector pesquero y el fomento de la cooperación entre los países.

Este documento tiene el propósito de señalar los problemas más relevantes que enfrentan los países de América Latina, referentes a los aspectos técnicos y organizativos de las investigaciones pesqueras, como información de antecedentes para la Novena Sesión del ACMRR a efectuar en junio de 1978 proximamente en Roma.

LOS RECURSOS PESQUEROS DE LA REGION

La mayor parte de las poblaciones de peces y otros organismos marinos de las zonas económicas de los países de América Latina se encuentran entre ligera y moderadamente explotados. Los camarones peneidos, las langostas y algunas poblaciones de peces se están explotando intensamente y hay poblaciones de peces pelágicos y demersales; así como de calamares oceánicos y especies no tradicioneales prácticamente inexplotadas.

Las poblaciones sometidas a regímenes de explotación intensa, tales como los camarones, las langostas y algunas poblaciones de peces bien localizadas, se han evaluado mediante la aplicación de modelos de producción, similares a los utilizados en la evaluación de poblaciones de peces de aguas templadas.

Los resultados obtenidos en la evaluación de estas poblaciones, han permitido implementar satisfactoriamente algunas medidas de administración en pesquerías de camarón del Atlántico y del Pacífico, en las pesquerías de camarón, de langostas y de pargos de Cuba y en las de cherna y otros peces demersales del Banco de Campeche.

A veces se han encontrado dificultades para la aplicación de los modelos analíticos de evaluación, debido a las diferencias existentes en los trópicos con relación a las aguas templadas, donde estos han sido originados, pero es interesante hacer notar que en los casos en que se ha contado con una base buena de datos estadísticos sobre captura y esfuerzo y las observaciones biológicas se hayan seguido con regularidad sistemática durante algunos años, los modelos mencionados se han podido ajustar a las condiciones tropicales sin muchas dificultades.

Estas experiencias conducen a pensar que la evaluación de poblaciones de peces y mariscos tropicales son específicas y que esta circunstancia no debe omitirse, pero cuando se dispone de información estadística pesquera y biológica, recolectada sistemáticamente durante varios años, los modelos de evaluación diseñados para las aguas templadas se pueden ajustar y aplicar con buenos resultados en la región tropical.

De lo antes dicho se desprende que en América Latina, para mejorar el conocimiento sobre los recursos pesqueros sometidos a un régimen de explotación intensa, con el fin de implantar medidas de administración pesquera, ante todo, se necesita incrementar los esfuerzos en la recolección de datos estadísticos y biológicos. Este objetivo se puede alcanzar propiciando el intercambio de experiencias entre los países para estandarizar metodologías, reforzando los programas de desarrollo pesquero regionales y organizando seminarios, grupos de trabajo y cursos de entrenamiento de corta duración sobre una base regional.

Las poblaciones de peces pelágicos pequeños, calamares oceánicos, peces demersales de profundidades medias y especies no tradicionales, se encuentran sometidas a un régimen de explotación moderada, ligera o inexplotados en algunos casos. Estas poblaciones constituyen la reserva pesquera principal de América Latina. Su potencial pesquero se ha determinado por métodos indirectos, por el examen de las tendencias que manifiestan las capturas en un período dado y en casos contados mediante la realización de surveys de arrastre y acústicos.

Las cifras obtenidas de esta manera, han resultado poco confiables, pero han sido útiles para señalar la existencia de recursos pesqueros abundantes y con ello atraer la atención de los gobiernos y de otros sectores interesados en la pesca.

En cuanto a los recursos pesqueros poco explotados de América Latina, se requiere, ante todo, fomentar su explotación en beneficio de los países de la región y en particular, para alcanzar un conocimiento mejor, perfeccionar los métodos utilizados para la estimación de la abundancia y organizar, en la medida de lo posible, pesquerías exploratorias; así como incrementar los surveys de arrastre de fondo y acústicos.

TECNOLOGIA DE PROCESAMIENTO Y DISTRIBUCION DE PRODUCTOS PESQUEROS

El consumo de pescado en América Latina es inferior a 6.0 kg percápita anuales. En varios países no alcanza incluso los 4.0 kg percápita. Hay razones de índole social que impide a grandes masas de la población de esta región participar más activamente en el consumo de pescado, debido a que su poder adquisitivo es muy bajo y en varios países el expendio de pescado se lleva a cabo con fines lucrativos.

Por esta razón, la tecnología de procesamiento y distribución del pescado; así como otros aspectos del desarrollo pesquero de la región, deben llevarse a cabo tomando en consideración situaciones sociales.

Independientemente de esta realidad, los mercados internos de productos pesqueros en esta región tropical por añadidura están muy poco desarrollados.

Salvo para la elaboraxión de camarones, langostas y algunas otras especies destinadas a mercados externos, la base tecnológica existente para el procesamiento y la distribución del pescado es de muy bajo nivel técnico.

En algunos países de la región se están desarrollando redes de centros de distribución de pescado congelado y semipreparado y algunos laboratorios y plantas experimentales llevan a cabo programas de investigación para elaborar nuevos productos apropiados para las condiciones climáticas de la región y de buena aceptabilidad para los consumidores locales. Pero los resultados de estos esfuerzos, que son muy importantes para algunos países, contribuyen en muy poca medida a elevar el nivel técnico y mejorar la situación de la tecnología de elaboración y distribución de los productos de la región.

La solución de estos problemas requiere esfuerzos mancomunados entre los países de la región. Quizás FAO pudiera contribuir al logro de este objetivo mediante el incremento de sus actividades en el sentido de propiciar información y fomentar programas de cooperación regional en el campo de la tecnología de procesamiento y distribución de los productos pesqueros.

Una forma concreta de ayudar al desarrollo de este campo en la región pudiera ser reforzando la base material de experimentación y brindando asesoramiento con personal internacional competente para aumentar la capacidad de algunos laboratorios seleccionados entre los existentes en la región. En tales laboratorios se pudieran hacer demostraciones con el fin de obtener productos apropiados, entrenar personal técnico y práctico y extender los resultados a todos los países interesados del área.

ACUICULTURA

La acuicultura representa un gran interés para los países de América Latina. La explotación de los recursos pesqueros de las aguas interiores de esta región es relativamente joven. Se trata por ahora de pesca a escala pequeña, con un impacto socioeconómico poco significativo, pero que promete grandes perspectivas, debido a la existencia de grandes recursos acuíferos y a la benignidad del clima, que favorece la adaptabilidad de muchas especies prolíferas y de crecimiento rápido.

El cultivo propiamente dicho, se ha practicado sólo en escala piloto, pero se han elaborado métodos para la cría de ostiones, almejas, mejillones y algunas otras especies, cuya introducción en la práctica se está realizando exitosamente. Del mismo modo, la repoblación de cuerpos de agua dulce con alevines de especies autóctonas y foráneas muestra resultados altamente satisfactorios.

Los problemas técnicos más relevantes a resolver para incrementar la acuicultura, consisten en la calificación de personal técnico y práctico, el mejoramiento de la base técnico-material para la experimentación y el intercambio de información y experiencia entre los países de la región.

Organizativamente, se requiere crear bancos de semillas para diseminar las especies de mejores condiciones entre los países de la región; fomentar los servicios de ictio-patología; fomentar servicios de extensión y crear centros especializados en la elaboración de alimentos de altos rendimientos, así como para la elaboración de medicamentos.

La acuicultura en América Latina, en sentido general, es una actividad que apenas ha comenzado, pero tiene a su favor el interés de los gobiernos y de sectores privados y no hay duda de que progresará en plazos breves. Es a la vez un campo donde se requiere la cooperacion entre los países de la región y entre éstos y las organizaciones internacionales especializadas.

CAPACITACION PESQUERA

La capacitación de cuadros técnicos de especialidades pesqueras así como de pescadores y personal de tierra relacionados con la elaboración y manipulación del pescado; es uno de los problemas a figurar entre los primeros lugares en la escala de prioridades para desarrollar la pesca en América Latina.

En la región existen escuelas universitarias, de nivel medio y Centros de entrenamiento elementales, cuyas capacidades para admitir alumnos son, en la mayoría de los casos, superiores a las necesidades de los países donde se encuentra cada uno de ellos. Estos centros de estudios pudieran ser utilizados de manera más racional en beneficio de la región, si existieran proyectos regionales con ese fin.

FAO pudiera contribuir al logro de este objectivo, mediante la coordinación de planes de entrenamiento entre los países, asignando profesores y equipamiento para mejorar la base material de estudios y facilitando el envío de estudiantes de unos países a los otros.

En esta región existe un centro de entrenamiento de pescadores ubicado en Trinidad y Tobago, que es objeto de un proyecto internacional. Del mismo modo, se pudieran seleccionar otros centros de estudio de nivel medio y superior, donde pudieran graduarse, además de nacionales, jóvenes provenientes de los otros países.

OTROS ASPECTOS DEL DESARROLLO PESQUERO DE LA REGION

La pesca significa una fuente importante de suministro de alimento y de oportunidades de empleo para las islas del Caribe y para muchas comunidades pesqueras diseminadas por los litorales de los países continentales de América Latina. En estos casos se trata regularmente de pesquerías artesanales, donde se emplean embarcaciones y artes de pesca de baja productividad.

Los programas de desarrollo pesquero nacionales y algunos regionales incluyen generalmente el desarrollo de este tipo de pesquería entre sus objectivos principales. Este aspecto debe ser tomado en cuenta por las organizaciones internacionales y brindar su apoyo, con el fin de contribuir a elevar el nivel técnica de los pescadores artesanales, mejorar sus técnicas de pesca, incluyendo embarcaciones más apropiadas y artes y equipos de pesca de más alta productividad.

Cuba ha desarrollado su economía pesquera de manera interesante. Los rasgos principales de la experiencia cubana, en lo que concierne a la pesca artesanal han sido:

- La organización de los pescadores en cooperativas, suprimiendo los intermediarios que constituyen una carga innecesaria para las comunidades pesqueras.

- La construcción masiva de embarcaciones más modernas y mejor equipadas. La mayor parte de ellas de ferrocemento, que son fáciles de reparar y de mantener en buen estado.

- La construcción de instalaciones de tierra para recepcionar, procesar y distribuir los productos de la pesca.

- La creación de escuelas para capacitar técnica y culturalmente a los pescadores.

Estas medidas se han llevado a cabo bajo un programa de desarrollo pesquero integral a corto y largo plazo, cuyos resultados han permitido, entre otros:

- Triplicar las capturas de peces y mariscos costeros.

- Aumentar la captación (entrada) de divisas por concepto de explotaciones de mariscos en más de 14 veces.

- Elevar considerablemente el nivel de vida y las condiciones sociales de los pescadores.

- Convertir la antes empobrecida pesquería artesanal en una pesca industrial próspera.

Algunos países de la región se han interesado por los avances de Cuba en la pesca y han concertado convenios de cooperación, mediante los cuales han estudiado conjuntamente recursos pesqueros de la región, han enviado jóvenes científicos, técnicos y estudiantes a capacitarse en las escuelas cubanas y han adquirido embarcaciones de ferrocemento.

Este modelo de desarrollo pesquero y algunos otros experimentos exitosos que se han llevado a cabo en la región, deberían ser objeto de estudio para las organizaciones internacionales, ya que los países en desarrollo frecuentemente asimilan las tecnologías elaboradas en otros países en desarrollo, debido a su similitud de nivel de desarrollo, idiosincracia y condiciones naturales.

COORDINACION DE ACTIVIDADES ENTRE PROGRAMAS DE DESARROLLO PESQUERO

Es característico actualmente en los países de América Latina el auge de los programas de desarrollo pesquero. Cada país cuenta hoy en día con, por lo menos, un programa de este tipo, de acuerdo con sus intereses nacionales, y muchas organizaciones regionales e internacionales auspician proyectos de desarrollo de la pesca con carácter subregional o regional.

En la región existe un espíritu muy bueno para la cooperación e incluso para la integración económica, además de la necesidad de cooperación científica y económica bilateral y multilateral motivadas por el nuevo régimen marítimo.

Todo esto favorece la coordinación de actividades entre países y de éstos con los programas auspiciados por las organizaciones internacionales. Pero aún quedan por coordinar muchos programas, lo cual resulta necesario para racionalizar esfuerzos, y aplicar con mayor rapidez los resultados de la investigación y de los experimentos a escala de pilotaje.

Las organizaciones internacionales, por su carácter, están en mejores condiciones que los países para ejercer dicha coordinación. Se sugiere a FAO tomar en consideración estas circunstancias y aumentar sus esfuerzos en pro de una coordinación más estrecha entre los múltiples proyectos de desarrollo pesquero nacionales, subregionales, regionales e internacionales que existen y sobre los que se establezcan en un futuro próximo en la región de América Latina.

APPLICATION OF SCIENCE AND TECHNOLOGY IN THE DEVELOPMENT OF FISHERIES

by

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INTRODUCTION

The importance of fish as a source of animal protein has been generally recognized and many countries throughout the world are engaged in intensive programmes to develop their fishing industries. In the developing countries fish forms the main protein food for many millions of people, and fish and fishery products have been used to counteract the problems of malnutrition.

In many countries fish is not merely regarded as a source of animal protein but as a valuable food generally. Some of the fishery products are internationally considered delicacies and do thus command very high prices in the markets. The great increase in fish consuming population throughout the world has created such a high demand for fish that the trend is for the fish to change from a cheap source of animal protein to an expensive food commodity beyond the reach of the low income groups.

The high demand for fish and fishery products necessitates the institution of urgent development programmes to exploit those resources which are known to exist and which hitherto have been untouched or only slightly exploited. The purpose of fisheries development is to increase fish production by increasing the size of catches without depleting the fish stocks in the oceans or fresh waters. The increased production can result in better income for the fishermen, most of whom live in rural areas, and this in turn would mean the raising of the standards of living for these rural populations.

It is expected that proper development in the fishing industry should be able to attract foreign investment and thereby open overseas markets for specialized products. The foreign trade would certainly bring the advantage of foreign currency earnings. The increased income from the industry is bound to create more employment opportunities and in this way the industry would help in solving the unemployment problems facing many countries.

The main problems hindering fisheries development in many developing countries are the lack of scientific knowledge of the available resources and lack of appropriate modern technology required in the fishing industry. For rapid development of the fishing industry improvement is required in various aspects of the industry.

FISHERIES SURVEYS AND FISHING METHODS

Fisheries surveys are very important for determining the extent of the resources available and the level of exploitation which would ensure sustainable yields. Some fishery resources may superficially appear to be overexploited while the actual fish stock available may indicate a different picture. This is the case in Lake Victoria where although there has been public anxiety about the depletion of certain fish stocks, especially of Tilapia, the survey conducted on the lake between 1967 and 1972 revealed that the standing stock of all species of fish was about 750 000 metric tons.

The present fishery on the lake produces about 100 000 metric tons annually. However, it is estimated that about 250 000 metric tons could be landed from the lake annually without depleting the stocks. It should be pointed out, however, that of the total standing stock of fish, about 600 000 tons are *Haplochromis*, the fish which do not feature prominently for direct human consumption.

In the survey conducted in Lake Turkana from 1971 to 1975 the preliminary estimates of the fish stock indicated that the maximum sustainable yield would be about 10 000 tons per year. However, in 1976 the fishermen on this lake landed about 17 000 tons of fish and there has not been any indication of adverse effects on the fish stock.

Various surveys have been conducted along the Kenya coast starting as early as 1965. In the early surveys estimations were made of the tuna resources within Kenya's reach. The estimations were made from the catches of the foreign fishermen including Japanese and Koreans. The conclusions reached confirmed that there were possibilities of developing tuna fisheries from our coast, and a deep sea fisheries project was initiated as a result of this.

Further surveys were conducted specifically for the crustacea resources in the inshore areas. The survey conducted from 1969 to 1971 showed that the shellfish resources in the inshore waters were capable of supporting a fishery of up to 500 tons per year. The average annual landing of crustacea along the Kenya coast has been about 200 tons. Under the Indian Ocean Fisheries Survey and Development Programme, a survey was organized from 1974 to 1976 to assess the resources in the areas of the Indian Ocean off the east African coast. This extensive survey revealed reasonable concentrations of fish stocks in some parts. Although our coastal waters did not indicate rich fisheries resources, it was estimated that with modern mechanized fishing vessels, it is possible to catch up to 7 tons of fish per day and that 3 to 4 tons of these could be highly valuable crustaceans.

The importance of fisheries surveys have been demonstrated in the past. These surveys should be conducted continually in order to assess more accurately the fish stocks and also to determine the changes taking place in the fish population as efficient fishing methods are introduced.

It is known that the introduction of modern fishing methods could considerably increase fish production from the resources which are currently under-utilized. Using traditional and older fishing methods, the fishermen in Lake Victoria are able to land an average of 50 kg of fish per boat per day. However, in the trials using mechanized boats equipped with trawl nets landings of up to 5 tons per hour for the large vessels and over 200 kg per hour for the small vessels have been realized. At the coast, small mechanized vessels equipped with trawl nets have been landing up to 500 kg of prawns per day from the inshore waters, while the traditional methods cannot produce more than 100 kg.

The use of large mechanized fishing baots would enable fishermen to carry more fishing gear per boat and possibly to set the gear several times per day. Some of the modern fishing gears which have proved fairly efficient include trawl nets, drift nets, purse seines and long lines. The introduction of trawl fisheries and purse seining have enabled fishermen to increase fish production considerably in many parts of the world. The practical demonstrations have shown that proper fishery surveys accompanied by the introduction of modern fishing gears and application of advanced technology can result in increased fish production.

In Kenya where the fish production for 1976 was about 41 000 tons and with resources in Lakes Victoria and Turkana and at the coast not fully exploited, it is estimated that the total fish landings could be increased to over 80 000 tons by 1983.

FISH HANDLING AND PROCESSING

Many fishing villages are situated in remote rural areas far away from the centres of population concentration. Due to the lack of handling facilities, the fishermen in these villages are forced to land only sufficient fish which they can dispose of immediately. In some cases simple processing methods have been developed to take care of the excess fish usually landed periodically in the year.

In order to encourage increased fish production with the introduction of modern fishing gears and methods, proper facilities for handling and marketing the catches must be provided. In the various fishing areas these will involve provision of appropriate jetties and facilities for quick landing of the fish. It has been demonstrated that the mere use of ice for chilling fresh fish, enables the fishermen to keep their fish in good condition for periods up to two weeks. For the handling of fresh fish and ensuring increased fish production, the basic facilities provided should include insulated cold rooms and where possible an ice plant from where fishermen can obtain ice for preserving fish right from the time the fish is removed from the water. In Lake Turkana provision of simple handling facilities for fresh fish has encouraged greater production by the fishermen. These reactions have also been experienced at the coast in the remote fishing centres in the Lamu district and in Vanga and Shimoni in the Kwale district.

In large fishing centres, more advanced processing facilities should be provided. These would include jetties equipped with conveyor belts for the quick transfer of fish from the fishing vessels into well established freezing plants. The provision of such facilities would stimulate the fishermen and thereby result in increased effort in fish production. A facility of this type was established at the Kenya coast in 1971 and this attracted many foreign fishermen who, between 1971 and 1974, landed more than 25 000 tons of fish caught in the off-shore deep waters.

Where it is not possible to preserve on ice, or freeze all the fresh fish landed, suitable processing methods should be developed. Many fishermen have resorted to sun-drying the fish as a simple method of preservation. The products produced, though accepted by some communities, are usually not of a high standard and their shelf life is generally short. Due to lack of technological know-how, and the high demand for fish, these products have featured prominently in the markets in developing countries. It would be useful if better and modern processing methods, such as smoking, using modern smoking kilns and canning were introduced to utilize the excess fish which cannot be absorbed in the fresh fish market.

The introduction of such fishing methods as trawling and purse seining usually result in catches of large quantities of fish which may be of low commercial value. This has been demonstrated in Lake Victoria where more than 80 percent of the trawl catches are *Haplochromis* and also at the coast in the Ungwana Bay where shrimp trawls catch large quantities of low value fish. For better development of the fishing industry it is necessary to find ways of processing these by-catches instead of discarding them at sea as is done in the shrimp fisheries. If the fishing vessels were properly equippped some of the so-called trash fish could be preserved for direct human consumption. Another use of these by-catches would be to produce fishmeal intended for animal feed. Objections have been voiced against the use of fresh fish for reduction purposes, especially in the developing countires where large populations still suffer from malnutrition. However, it should be pointed out that even in the developing countries, the consumer preference would militate against the use of large quantities of many of the species in the by-catch and such fish as *Haplochromis* for direct human consumption.

FISH MARKETING

One of the major problems affecting fisheries development especially in the developing countries is the poor means of communication between the fishing areas and the markets. Many fishing centres with rich fisheries resources are situated in remote rural areas without proper communication links with centres of population concentration. Because of these problems the fish marketing systems in many developing countries traditionally consist of several middlemen handling progressively smaller quantities in the distribution chain from the fish landing to the point of consumption. These systems in some cases are fairly efficient or are often so deeply rooted that they have become difficult to change. Unfortunately, with so many middlemen, the consumer prices for fish are often much in excess of the landing prices and this renders fish too expensive for the low and middle income groups who after all are the most undernourished.

For proper development of the fishing industry, fish marketing should be organized to eliminate the systems involving several unnecessary middlemen. It is felt that the organization of fishermen's cooperatives or some other fishermen's trading groups to integrate fish supply and initial marketing functions would benefit the industry. However, such organizations must be provided with qualified management and proper direction.

The marketing organization should ensure that the fish are preserved and processed properly and in accordance with the consumer preference. The organization should be equipped with suitable means of transportation by which the products can be moved from the fishing centres to the markets. For transportation of fresh fish and frozen fish products, refrigerated trucks have been employed successfully. However, proper well maintained roads are required for such transportation.

A dramatic result of the improvement of means of communication has been experienced in Lake Turkana where the fish production increased from 5 000 tons in 1975 to more than 17 000 tons in 1976. Because of the slightly improved roads, traders were able to introduce modern fish transporters including refrigerated trucks. The fishermen have thus been enabled to dispose of part of their catch without any delays.

It is considered that a fish marketing organization properly established would stabilize fish prices, instil a sense of pride and security in the fishermen and also stimulate general spontaneous development. Such an organization would be responsible for the selection of the various fish products conveniently processed for the appropriate markets.

CONSERVATION AND MANAGEMENT

The development of the fishing industry would be short-lived if management measures were not instituted to ensure the conservation of the fish stocks. Fishermen in general are always keen to exploit the resources to produce maximum short-term yields without considering the conservation of stocks. It is upon the responsible authorities to guide the fishermen by making rules and introducing administrative principles to ensure sustainable production.

The introduction of more efficient fishing gear has to be accompanied by strict law enforcement if the particularly valuable fish stocks are to be conserved. Even though appropriate measures may be introduced to regulate the fisheries, some types of fish will still be adversely affected by the use of more efficient gear. In these circumstances, it is important to conduct scientific studies to determine whether the quantity of such fish could be increased by artificial culture and restocking.

Programmes of artificial fish culture have been successfully undertaken for the Salmonoid fishes (salmon and trout) and some warm water fishes such as tilapia and carp in many parts of the world. The Japanese have maintained the salmon fisheries in their sea areas by the artificial introduction of over five million young fish raised in culture farms every year. Many other countries are also supplementing their fish stocks by such practices.

In Kenya the Lake Naivasha fishery is based on successful stocking of *Tilapia* species and the black bass (*Micropterus salmoides*) in the lake. Similar introductions were made in Lake Victoria where non-indigenous species of tilapia, including *Tilapia nilotica*, and the Nile perch (*Lates niloticus*) were stocked between 1955 and 1962. These introduced fish in Lake Victoria have done so well that now they feature prominently in the fish landings. These artificial fish cultures should be carefully studied and where practicable should be applied to improve the quantity of fish available. Apart from the stocking of the natural reservoirs, great potential exists for fish farming in Kenya, especially in the Central, Nyanza, Western, Eastern and Coast provinces. Some activities are already going on in fish farming in the country, however it is considered that with improvement of technology and exploitation of all the potential available, fish farming alone could yield up to 20 000 tons of fish per year.

In order to implement the developments outlined above successfully, availability of well trained personnel in the various fields will be vital. The fisheries surveys require qualified and trained scientists while the improvement of fishing methods need qualified and experienced gear technologists. Such personnel must be available for the various sectors of the fishing industry to ensure that the development initiated is maintained. It is very important to organize effective training programmes to enable the local personnel to acquire expertise in the necessary advanced technology.

SUMMARY AND CONCLUSIONS

The realization of the importance of fish as a valuable food has generated great demands for fish throughout the world. These demands, being far in excess of the supply, have resulted in fish becoming a highly priced food commodity. The status of fish has therefore tended to change from the cheap source of animal protein to an expensive food commodity beyond the reach of the low income groups.

In many countries especially in the developing world, not all the available fishery resources are fully exploited. In these countries great potentials still exist for the development of the fishing industry to bring about increased production. The major problems in these areas are lack of scientific knowledge of the available resources and lack of modern technology required in the fishing industry.

For the accelerated development of the fishing industries in the developing countries, it will be necessary to organize continuous scientific surveys to ascertain the extent of the resources; introduce modern mechanized fishing gears and methods; improve fish handling and processing and the marketing channels including means of communication to the markets. It is also important to institute conservation and management measures which may involve artificial culture of some stocks of fish and enforcement of regulations to guard against depletion of valuable fish stocks. It may therefore be concluded that the application of science and modern technology would be useful in stimulating rapid development in fishing industries, especially in countries where extensive resources are currently underexploited.

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PRINCIPLES AND PROBLEMS IN DETERMINING ALLOWABLE CATCHES

by

The FAO Secretariat

Background

A vital step in managing renewable natural resources, such as fish stocks, is the control of the amount removed, either explicitly (e.g., as catch quotas) or indirectly (e.g., closed seasons, licence limitation). This has been recognized in the Law of the Sea discussions, where the first paragraph of Article 61 of the Informal Composite Negotiating Text dealing with the Conservation of Living Resources reads:

> "1. The coastal State shall determine the allowable catch of the living resources in its exclusive economic zone."

The problems then immediately arise of the principles that should be used in determining the allowable catch, the methods to be used in calculating the appropriate magnitude for a given stock, once the principles have been established, and the coordination of allowable catches from stocks occurring in the area of jurisdiction of two or more coastal states, or on the high seas. The last problem is recognized in Articles 63 (for stocks in several national jurisdictions), 64 (for highly migratory species), and 117, 118 and 119 (for stocks on the high seas), though all except Article 119 are largely confined to calling on states to implement appropriate coordination and cooperation.

Now that there is broad agreement with the LOS discussions on fishery matters - though final signature, let alone formal ratification of an actual Convention may be some way off - many countries facing the opportunities and responsibilities placed on them by extended jurisdiction are looking for guidance on their problems of setting allowable catch. This need for guidance is made more urgent for many countries, including a high proportion of developing countries, because with the highly successful expansion of fisheries throughout the world in the post-war period, the stocks off their coasts have become heavily exploited and are in urgent need of management.

Principles

Recently there have been wide discussions on the principles of management and the objectives to be aimed at. In some cases this has led to rather detailed specification and definition of the principles and objectives to be used. This process has gone farthest in the IWC, where the New Management Policy spells out precisely what level of catch should be allowed in accordance to the current state of the stock and the magnitude of the sustainable yield from it. More commonly, objectives have been expressed in rather general terms, e.g., "rational utilization", "maintenance of optimum yield", etc.

The former approach is clearly useful when there are different groups concerned with resource management which have very different interests. This was the case with whales, where the environmental movement was anxious for very low catches - if possible zero - while the whaling countries wanted, at least in the short term, fairly substantial catches. Agreement on the level of the allowable catch in respect of an individual stock was in this case greatly facilitated by having the discussions based on some previously agreed principles, e.g., that any stock more than a given percentage below the level giving maximum sustainable yield (MSY) should receive complete protection. The rigid approach can, however, easily lead to problems when there is a change in objectives, or when it becomes apparent that the target chosen does not necessarily lead to the desired objectives. For example, the IWC

itself for a time based its actions fairly rigidly on a target of MSY, only to realize that it did not lead to the fulfilment of several desirable objectives (high economic performance, minimum risk to the stocks, etc.). Experience in IWC also suggests that a rigid and precise formula for setting catch quotas leads to difficulties when not matched by equally precise and accurate and reliable knowledge of the stocks and, in particular, when stock estimates change considerably from year to year as a consequence of additional data.

There are advantages, therefore, in avoiding too precise a formulation of objectives in permanent and legally binding form, e.g., in basic fishery legislation or in international conventions. Here, vague but inspiring phrases such as "conservation and rational utilization" can be sufficient to indicate the broad purpose. This leaves open the question of how the basis should be determined for measures to be applied in any given situation. Ultimately, this must arise from broad national policies. Fisheries contribute in various ways to national wellbeing, mainly in providing high quality protein, but often also in providing foreign exchange as well as employment and profitable economic activity in areas or parts of society that are often less well-off than the country as a whole and often have little other opportunities for successful employment. At the same time, fisheries are consumers of resources (capital, fuel, etc.) which are sometimes scarce, and can nearly always be used elsewhere.

Most of these outputs and inputs can, for a given stock of fish, be related to the amount of fishing (technically the fishing mortality coefficient, F) and some of these relations are shown in Figure 1. In addition to the quantifiable relations, there are less quantifiable aspects of the fisheries that will also be affected by changes in the amount of fishing. For example, the year-to-year variability of the stock, and hence of catches, usually increases as fishing increases, and may reach the point at which the stock becomes unstable and may collapse. Also omitted from the figure are considerations of the effects on other fish stocks and the catches from them. These could be in either direction. Increased fishing on one stock could increase catches of species of fish that prey on, or are competing with, the primary species. Catches of other species could be reduced if the primary species is an important food item for them.

At any given moment a country will choose a balance between the various aspects of the fishery that may be different from the balance chosen at other times or by other countries. Different criteria will result in different levels of fishing being considered optimum. For example, the level of effort giving the greatest yield in weight (MSY), A in Figure 1, is higher than that giving the greatest net economic return (MEY), B in Figure 1. The history of the fishery can affect the desired level. For example, from the point of view of employment, a greater amount of fishing may be desirable if the fishery has already expanded and, if anything, there is a surplus of fishermen who might need resettlement than if the fishery is still at a low level, and the question is of increasing the number of fishermen who may need training.

It is, therefore, impossible to determine some unique level of fishing that will be the best or will provide the "optimum population" under all conditions. However, the desirable balance between objectives leading to high rates of fishing (gross production, export earnings, employment, etc.) and those leading to less fishing (high catch rates, low input costs, greater stability in the fish stocks) is likely to be achieved somewhere around the left-hand shoulder of the curve of yield in weight, often quite close to the point of MEY. This is the region where the rate of increase of catch, etc., begins to slow down significantly and becomes out of balance with the increase in costs, etc.

Determination of the total allowable catch

Given the objectives and principles, as discussed above, the determination of the actual level of the total allowable catch for the next year or fishing season requires scientific research. The essential output of this research can be expressed by two graphs. First is

the relation between the amount of fishing and the annual yield that could result on an average if that level of fishing were maintained over a period. This is the curve in the upper part of Figure 1. Most of the other input and output characteristics of the steady-state fishery can be deduced from this relation between total catch and fishing effort. Second is the relation between the amount of fishing and the catch that would be taken during the coming season with that amount of fishery. This is shown by the family of curves in Figure 2. The relation is different, depending on the size of the stock at the beginning of the year; it is different from the steady-state relation of Figure 1 because during one season the stock will not have time to adjust fully to changes in the amount of fishing.

The actual scientific work in determining these relations are outside the scope of this note but two points should be made. First, the work is not easy; second, the work and the results from it must relate to the whole population, regardless of manmade legal boundaries. There are several consequences of these. Since the work is difficult, it must be adequately supported and supported over a long enough period to be effective - emergency programmes to provide an answer in a few months (or even a couple of years), however well funded, are no substitute to well planned scientific research extending over several years. Few countries have the resources and the depth and breadth of scientific skills to do all the work by themselves, and cooperation between countries to make the best use of the joint expertise would be invaluable. Cooperation is essential when stocks cross boundaries of national jurisdiction and at the absolute minimum should include pooling of data on all catches taken from the stock (i.e., exchange of catch and effort statistics, etc.).

Allocation of catches

Where more than one country is interested in the harvest of a stock of fish the determination of the magnitude of the total allowable catch still leaves open the question of how the total should be divided. Three situations can be distinguished: where a stock occurs in more than one area of national jurisdiction; where it occurs on the high seas (and possibly also within one or more national jurisdiction); and where it occurs only in one jurisdiction, but the country concerned at the present time cannot fully utilize it.

The first situation requires negotiation between the countries concerned to reach agreement on the shares to be taken by each country. These shares could be expressed as the proportion of the total catch taken within each national jurisdiction or as the proportion taken by the fishermen of each country. They are not necessarily the same thing, unless fishermen are restricted to fishing only within their own countries' area of jurisdiction. Where those areas are small and there are marked seasonal movements of fish between jurisdictions, there could be advantages in the fishermen being able to follow the fish wherever they go, thus providing a more regular supply.

The negotiations could take into account matters of joint interest to the countries other than fisheries and the fishery aspects could include matters of trade, etc., and the relative importance of fisheries in different national economies, as well as the narrower fields of the fish themselves and their capture. Among the latter obvious considerations would be the patterns of distribution of the fish, at all steps of their life history - where they spawn, their nursery grounds, the main feeding areas, as well as the areas where they are most easily caught - and the share of the total catches taken by each country in recent years. With such a range of possible factors to be taken into consideration, there is unlikely to be any simple formula or principle that can be used in determining allocations in all situations. Also it is is unlikely that the allocations in respect of any given stock will remain constant. In the initial years of any agreement, it is likely that allocation will be largely based on historical catches (since this will require the least adjustment, possibly painful, by individual fleets) but later other factors will become important, particularly if there are changes in the general pattern of fishing. For example, as fisheries expand there is often a change in emphasis from large, valuable predatory fish to smaller, less valuable but more abundant species. The initial fishery may take place on the spawning grounds of the larger species, rather than their feeding grounds (possibly in a different jurisdiction) and the allocation might be made on that basis. Later, as fishing develops on

the species that provide the food for the larger, predatory fish, the country in which the feeding grounds of the predator occur may be unhappy to undergo what would appear to be losses in possible catch from the food fish without getting much benefit from the predators and the allocations might be adjusted. These difficulties should, however, not be insuperable obstacles to agreement. Only a small number of countries are concerned in relation to any one stock, and the benefits from agreement are very considerable. A country might hope to increase its share of the total from an uncontrolled fishery but the costs would be out of proportion to the benefits.

The problems of allocation are much greater when all or part of the catches are taken on the high seas beyond national jurisdiction. The stocks mainly concerned are the so-called highly migratory species (tunas, etc.), but include also a small proportion of other species currently harvested (e.g., cod on the Flemish Cap) and much of the so-called "unconventional" species (lantern fish, etc.). Unless the allocation is agreed upon by all countries it will always be possible for new entrants to come into the fishery. In fact the more successful that arrangements are between current participants in managing the resources and maintaining high catch rates, the more likely it is that other countries will find an interest in entering the fishery and thus disturbing the arrangements. The difficulties should not be exaggerated. Only a small proportion of the countries with access to the high seas will have any significant interest in any given fish stock and these will mainly be the coastal countries adjacent to the part of the high seas in question. Among these, even those with little or no current fishing and with hopes of ultimate expansion should find it attractive to accept the restrictions implied by allocation of catches so as to gain the advantages of conservation - higher catch rates, etc. - provided there are adequate mechanisms for potential future adjustments of the allocation in their favour.

Problems will arise in relation to the principles to be followed in determining allocations, particularly in respect to the weight given to coastal countries and catches taken within national jurisdiction. Should, for example, the latter be given priority so that allocations would be given to catches on the high seas only to the extent that the total allowable catch cannot be taken within national jurisdictions. Again, should different principles be followed in respect of "highly migratory" species, anadromous or catadromous species, and others. The Informal Composite Negotiating Text is not clear on these points, except for anadromous and catadromous species, for which responsibility and authority are clearly given to the states of origin, or in which the fish spend most of their lives.

For stocks which remain within the jurisdiction of a single state but which cannot be fully utilized by that state, the principles laid down in the ICNT are clear. The coastal state determines the TAC (Article 61), subtracts its own catch, and (Article 62(2)) "give other states access to the surplus of the allowable catch". All would be easy and straightforward if the process of determining the TAC, taking account of the "relevant environmental and economic factors" referred to in Article 61, led to a clear and uniquely defined value. As discussed in the earlier sections of this note, this is not the case. Quite different values of the optimum amount of fishing and hence the TAC, arise when different objectives are chosen.

When the species of fish concerned is not exploited by local fishermen and especially when it preys upon or competes with species that they do exploit, and when there is little physical interference (e.g., trawlers damaging lobster pots) between local and non-local fishermen, it should be possible to find some level of fishing, probably on the left-hand shoulder of the yield/effort curve, as satisfying to a generally acceptable degree to most objectives. From this the TAC can be determined and the consequent arrangements made regarding licensing, etc., as suggested in the ICNT.

When local fishermen are exploiting the stock, even to a limited extent, there is a serious conflict of objectives. Any fishing by non-local vessels will cause a decrease in the catch per unit effort, i.e., in the average catch of the individual fisherman, even if the stock is still lightly exploited. This clash of interests can be eliminated if the

local fishermen receive benefits as a result of the foreign fishing at least equal to the costs due to decreased catch rates. This could be arranged by, for example, the foreign fleets paying fees that are used for improving the landing facilities used by local fishermen. The costs can be readily calculated from the yield/effort curve and will be equal to the difference between the catches taken by the foreign vessels themselves and their marginal catch (that is the amount that the additional effort they exert adds to the total catch of all vessels, see Figure 1). These costs, plus the costs of research, administration and enforcement that fall upon the coastal state if it is to fulfil its responsibilities for conservation of the resource (see, for example, section 204(10) of the U.S. Fishery Conservation and Management Act) represent the basic charge (whether taken in direct charges or by other arrangements) that the coastal state might expect to obtain from non-local fisheries if the former is not to lose by the activities of the latter. Consideration may well be given to additional fees or other remuneration, as described in Article 62, para. 4(a) of the ICNT, so that the coastal state can participate in the benefits of the utilization of the resources off its coasts.

Points for Consideration by ACMRR

The Committee is invited to take the points outlined in the above sections into account when discussing item 5 of its agenda and when considering advice it may give to FAO and its Member Governments. In particular, the Committee may wish to consider:

(a) the general principles that could be pursued by countries determining management actions and the relation of these to general national policies;

(b) the detailed principles and policies that might be used in setting the level of the total allowable catch;

(c) principles that might be followed in allocating shares of the total allowable catch to different participants;

(d) the impact that the application of these principles would have on the demands from research workers at the national, regional and international level, giving particular attention to changes that might be needed in the nature or general magnitude of research programmes;

(e) actions that should be taken by FAO to deal with these new demands and the changes in research priorities.

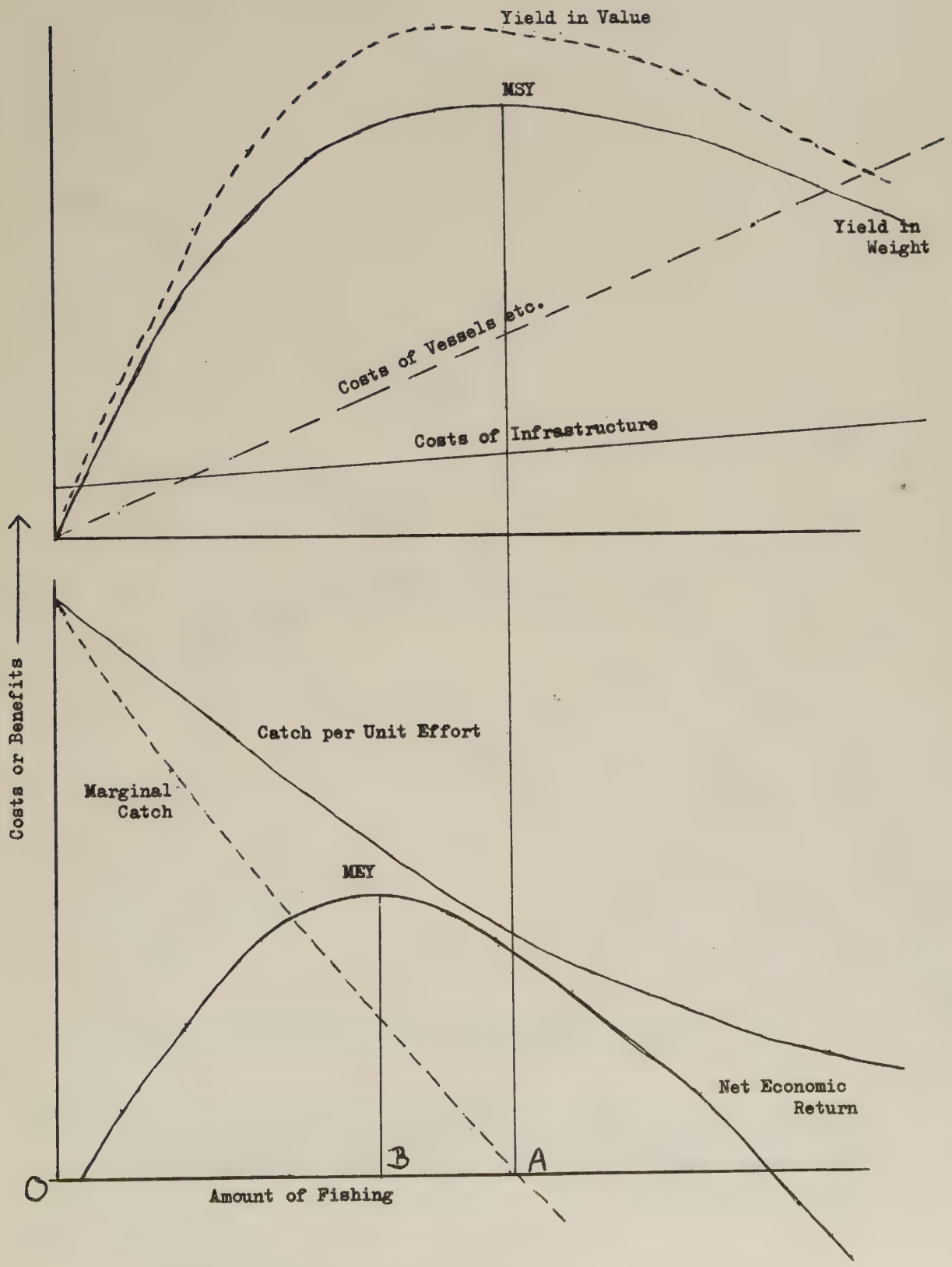

Fig. 1 Relation of different measures of inputs (costs, etc., outputs, yield in weight or value, etc.) and other characteristics of the fishery, to the total amount of fishing

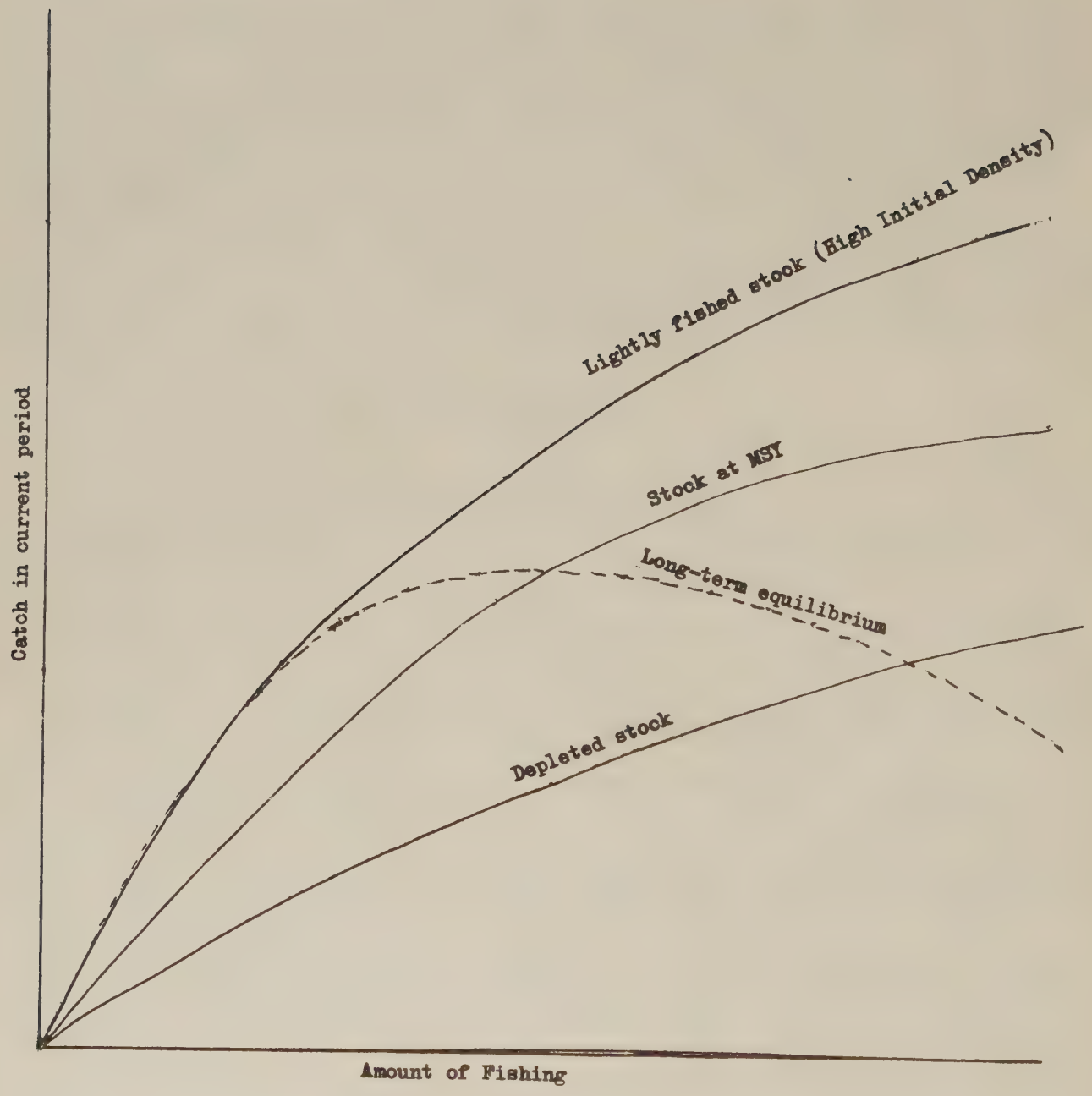

Fig. 2 Relation of catches during the fishing season to the amount of fishing, shown for different levels of stock at the beginning of the season. The long-term equilibrium relation between catch and effort is also shown for comparison

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